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Forthcoming Events.

DECEMBER 2.

British Foundrymen's Association (Lancashire Branch).—"The Growth of Cast Irons after Repeated Heatings," by Prof. H. C. H. Carpenter, M.A., Ph.D., Manchester University.

DECEMBER 8

British Foundrymen's Association (London Branch).—"Solidification of an Iron Casting in the Mould," by Prof. T. Turner, M.Sc., Assoc.R.S.M., Birmingham University.

DECEMBER 9.

British Foundrymen's Association (Birmingham Branch).—General Discussion.

British Foundrymen's Association (Scottish Branch). — "Foundry Metallography," by J. S. G. Primrose, A.I.M.M.

DECEMBER 12.

British Foundrymen's Association (Sheffield Branch).—"Testing of Moulding Sands," by R. Mather, Woolwich.

NOTES AND COMMENTS.

The Physical Properties of Cast Iron.

Dealing with this subject before the London Branch of the British Foundrymen's Association, last month, Mr. F. J. Cook showed effectively the importance of giving due consideration, not only to the chemical composition of cast iron, but also to the conditions of pouring and cooling. The same mixture may give a wide variety of results in casting according to the pressure of blast used in melting it, the casting temperature, and the rate of cooling; and, consequently, one casting often shows a variety of structures when examined under the microscope and a variety of strengths under test. In the more enlightened foundry circles these matters have, of late years, been receiving increasing attention, but there are many founders who scarcely yet understand that the best of mixtures may refuse to give a good casting if subjected to wrong conditions of casting temperature and cooling. Many of the difficulties in this matter, it must be admitted, are often associated with design, but much can be done by the use of chills and the avoidance of over-damp moulds, to obtain sound metal in thick sections, and to avoid hard, chilled metal in thin sections. By such means it is possible to overcome much of the trouble resulting from considerable irregularities in design and to prevent sponginess and weak structure in special parts. The use of chills could, with advantage, be adopted far more widely than is at present customary; but at the same time it might be insisted that the designer, too, should meet the case where possible by paying more regard to the difficulties imposed upon the founder by awkward designs. As regards the founder's part, Mr. Cook's contention that where a good, dense, sound casting is desired, the metal should be got from the cupola as hot as possible, will meet with the support of those who have tried the relative effects of hot and dull melting respectively. It may safely be said that many of the defects which occur in castings produced in daily practice might be avoided by the use of hotter metal; and since under ordinary conditions of cupola working it is difficult to exceed the maximum temperature for obtaining the best results, there is little danger of overheating the metal.

Among the qualities to be considered in obtaining the maximum physical properties in cast iron, probably the most interesting is that which Mr. Cook terms "body," or, "that something which is at present not shown by analysis, but which greatly affects the physical condition of the metal." That irons of the same ultimate analysis give widely different results under test has been long appreciated; in fact, that is at the root of the preference shown for irons of certain makes, particularly in the past, for obtaining certain results. The preference was not based on the chemical analysis, for that did not justify the difference between various irons; it was a question of inherent qualities which were not even destroyed in re-melting. The fact that the ultimate chemical analysis shows only the con-

stituents of the iron and not the conditions in which they exist (except for the distinguishing of combined carbon from graphite), to a great extent explains this; for the condition in which the constituents exist (affected by smelting and first-casting temperatures, and also by re-melting and pouring temperatures and rate of cooling in the final casting) is of more consequence than the actual composition of the metal. The demand that chemical analysis should be accompanied by examination of fracture for grading purposes, therefore, is not a matter for surprise; and this is coming to be regarded as the soundest basis on which to work, since the fracture gives a fair general indication of the condition of the carbon in particular.

Carbon and its Influence.

Carbon, as the most influential of the constituents of cast iron, has not hitherto received proper attention. Silicon, certainly, is regarded as important chiefly owing to its effect on the condition of the carbon, but too much reliance is placed on the influence of silicon, for there are other factors of equal if not greater importance in controlling the condition of the carbon. Under certain conditions, and within certain limits, the carbon in cast iron will respond fairly regularly to decrease or increase in the silicon content, an increase conducing to the formation of graphite and *vice-versa*. But it has been conclusively proved that under other conditions this feature is not observable, though the generally observed effect of silicon has led many foundrymen to advocate grading on the basis of the silicon content. The futility of this was shown by Mr. E. Adamson in a Paper before the last meeting of the Iron and Steel Institute (published in our last issue), in which he stated that :—"It is not difficult to produce in the blast furnace very open grey iron containing 0.40 per cent. of silicon, and grey iron containing 0.20 per cent. of silicon, and the author has made to specification refined iron with grey fracture, containing silicon 0.40 per cent., as also an iron with silicon 0.15 per cent., having a hard, mottled fracture—such pigs being 4 by 4 in. in section and cooled in the ordinary way. Carbon is precipitated as free carbon virtually in the absence of silicon, and this precipitation, in the case of the manufacture of pig-iron, primarily depends upon the original temperature to which the iron is raised in the blast furnace."

The question has often been asked, Why should certain pig-irons consistently display certain characteristics, apart from those which chemical analysis indicates, even after re-melting in the cupola? If it be granted that carbon is the controlling element, and that the condition in which it exists governs the strength and other qualities of the metal, considerable light is thrown on the subject by Mr. Adamson's contentions, briefly expressed in the above-mentioned Paper, and later somewhat more fully before the Staffordshire Iron and Steel Institute. He does not stop at the common classification of combined carbon and graphite, but claims that there are three distinct forms in which graphite separates out, each of which is produced at different temperatures. As each of these forms appears to exert a distinct influence on the grade of the metal, it is desirable to consider them further.

The Conditions of Graphite.

Mr. Adamson describes the three modifications of graphite in ordinary grades of pig-iron as follows :—

(1) The finely-divided state of free carbon which is found in close fractures of cold-blast grey iron, such as Nos. 5 and 6, and which is the first stage in pig-iron from white iron. These will be found to be of somewhat different character from the amorphous carbon seen in malleable cast iron, which is liberated at 900 deg. C. and under, that is, below the recognised recalescence point of graphite.

(2) The peculiar crystallisation in which the graphite shows up like a star. This peculiar appearance is an intermediate stage between the finely-divided graphite and that described in the next paragraph, and may possibly be the appearance which graphite takes in changing from the fine variety just described to that next described in paragraph 3. That it is an intermediate state appears to be proved in that it frequently occurs to a moderate extent in pig-iron when a furnace has been turned off cold-blast on to hot-blast iron, and *vice-versa*.

(3) The full flake of graphite such as is found in a No. 1 pig-iron. This is of a refractory nature, which Moissan so ably described, and under certain conditions it produces "kish," the influence of which is well known both in the iron foundry and the steel works.

He also mentions as a fourth, the condition of graphite which is found in low-grade ferro-silicon. For these conditions of free carbon and graphite the following designations are suggested :—For the amorphous carbon, α-free carbon; for the fine state described in paragraph (1) β-graphite; for the state described in paragraph (2), γ-graphite; for that in paragraph (3), δ-graphite; and for practical works purposes it is hardly necessary to go beyond this stage. In the use of pig-iron, he states, the influence of these varieties of graphite on the physical properties, or structure, of the iron, are distinctive, and the three varieties fully described above pass through each stage as a function of temperature and time, and having reached the stage described as third (or δ-graphite), it appears impossible—without chilling—to destroy this variety so as to produce β-graphite without its passing through the stage of γ-graphite, which points to allotropic changes.

These contentions offer an explanation to the characteristics of certain irons, as previously mentioned; for it will be seen what a great influence the carbon has on fracture, and hence on the grade. While the other constituents also exert their individual influences, it would appear that these are only contributory—perhaps, as suggested by Mr. Adamson, through their influence on temperature. The important feature, then, is the *condition* of the graphite, rather than the amount as generally understood, for the behaviour of each of the varieties of carbon is quite different in use in both the iron foundry and the steel works. Mr. Adamson remarks that it has been generally assumed that each re-melt of pig-iron in the cupola changes its grade, but that this is not necessarily so in all cases. He mentions a specific case where No. 1 hematite and steel scrap were melted together in the proportion of nearly half and half, and in which the silicon contents were reduced from about 3.50 per cent. to under 1.50 per cent., and yet the fracture resulting from the hematite and scrap mixture was No. 1 iron. This was under ordinary foundry conditions. The point is that whether the iron changes its grade or not in the re-melting depends not so much upon contents of silicon, sulphur, phosphorus, and manganese, or a combination of these, but primarily upon the condition of the carbon as disclosed in the fracture, together with the total carbon contents, and the temperature at which it is melted. These are the primary considerations in the use of iron in the foundry, regardless of the composition of the pig.

He continues :—"When the condition of the graphite is destroyed, on re-melting δ-graphite passes through the γ-state before it reaches the β-state, under normal cooling conditions such as experienced

in works practice, and if grey iron contains certain forms of graphite and is chilled to white, this white iron constitutes a specific variety, the reason being that regardless of analysis it does not behave under heat treatment in the same way as a white pig-iron would which had not been chilled from grey. On melting two irons of same silicon contents, etc., differing only in carbons, one being a natural white and the other a 'chilled' white, and casting into the same sections, one would be white and the other grey."

Effect of Chilling a Grey Iron.

In one example quoted, a white iron of the analysis:— CC., 2.98 per cent.; GC., traces; Si., 1.89 per cent.; S., 0.27 per cent.; P., 1.62 per cent.; Mn., 0.29 per cent.—was melted with an addition of manganese to produce manganese 1.00 per cent. and because a grey fracture was obtained it was concluded that the manganese had taken up the sulphur, which influenced the fracture of the iron, the latter becoming grey. Mr. Adamson does not accept this statement, and believes that certain white irons will melt grey under any good working conditions, and these can be told from the appearance of the fracture. He considers it probable that this particular fracture of iron which was high in silicon had been "chilled" in the furnace hearth, with the result that a white iron was produced, but a white iron which was really a "freak" white. "This chilling effect may be more easily understood by those engaged in foundry practice from the fact that the first iron melted in the cupola is considerably harder than the following part of the metal, because of the chilling effect on the iron as it drops on the cold bottom of the cupola; thus, the first lot of iron melted in the cupola gives up a great part of its heat to the cupola, thus heating the cupola and putting it into a condition to enable the next iron to retain its heat. Then at the end of the melt the last metal is 'chilled' by excess air unless care is taken."

Here, Mr. Adamson runs up against one of the pet notions held by foundrymen, to the effect that sulphur is the cause of hardness in the first metal from the furnace. He does not agree with this, as he has proved that the sulphur need not vary materially from the first cast right throughout the day's melt on the same burden of iron. He states that if an iron from the blast furnace or from the same ladle of metal were poured into sand pigs and into chilled moulds of the same section, the latter would be harder, and whilst the iron cast into chilled moulds would be harder on fracture than the sand pig, it would be a degree softer than the original fracture when melted, but still not as soft as the sand-cast pig; and in re-melting both irons under the same conditions, that re-cast in the same mould would be consistently harder on the same melt. Chilling does not entirely destroy the character of graphite, for he has met with white iron showing a fracture distinctly graphitic, and in mixing this with a hard grey iron in order to get a mottled fracture in the casting, an extremely soft grey iron was obtained.

It will be seen that Mr. Adamson's statements uphold the contention that carbon, primary temperature, and time, combined, are the most important influences in regard to producing fractures of pig-iron, quite independently of the other impurities present, which have admittedly contributory influences, but of a secondary character only, and probably through their influence on the temperature; and that the grade of the iron is also altered in good or bad foundry working. Carbon, he considers, is fracture, and no method of grading will be successful which in effect leaves out of question the carbon. A close-grained casting cannot be obtained from an open iron unless the size of the graphite flakes has been "destroyed," which can only be done by proper mixing and manipulation in the foundry.

It would be foolish to deny the effect which silicon has been shown to have in softening iron; but it should be borne in mind that there are conditions under which that effect will not be experienced. Relegated to its proper position, however, silicon can be made an extremely useful element, though it should be regarded in relation to the condition of the graphite as shown by the fracture, and not as an independent positive indication of any quality. Popular opinion swung rapidly from the old method of judging a pig-iron by its fracture alone to that of chemical analysis; but in English practice, particularly, the conditions of blast-furnace working vary so in different plants that the analysis, apart from the fracture, is of little use in determining the physical condition of the iron. It might serve were blast-furnace temperatures attained in the cupola, but they are not, and it is necessary to consider the metal as we find it, since its characteristics as pig-iron are largely retained in the re-cast state.

Halifax Branch of the British Foundrymen's Association.

A new Branch of the British Foundrymen's Association has been formed at Halifax, and promises to be a very successful addition to the parent body. The inaugural meeting, convened by circular, was held on Saturday, Oct. 14, when there were about eighty persons present. It having been decided after due consideration to form a Branch, forty-three of those present gave in their names as members. Mr. Hugh Campbell (Campbell Gas Engine Company, Halifax) was elected president, and Mr. J. G. Robinson (Foundry Manager of the Campbell Company), secretary. A committee, consisting of Messrs. A. Lazenby, W. Noon, A. Leach, W. Smith, A. Brearley, Limb, and A. Midgley, was also appointed, and Mr. R. Buchanan, of Birmingham, gave an interesting address on the advantages of association. He advised foundrymen to take in hand the education of their class, and endeavour to make foundry work more scientific and progressive. The next meeting was held on Oct. 28, when a Paper was read by Mr. Richard Carrick, foundry manager to Messrs. Parkinson & Son, Limited, Shipley, on some general principles of iron founding. Since then a number of new members have been enrolled, and there are now 95 or 96 names on the books. Thanks are due to the warm interest shown in the welfare of the Branch by Mr. Hugh Campbell, and to the zeal displayed in promoting its success by Mr. J. G. Robinson (the Secretary), whose address is 17, Gibraltar Road, Halifax.

A further meeting was held on Saturday, November 11, at the Halifax Municipal Technical College, when Mr. Hugh Campbell presided over a large attendance. A Paper was read by Mr. Sidney Smith, of Chesterfield, on "The Composition of Pig-Iron in Relation to Grade Numbers and Fracture." The Paper was of a technical but most interesting character and was well illustrated by specimens of pig-iron and diagrams showing the constituent elements, the atomic weights and specific gravities of each one of the six kinds dealt with. In his concluding remarks Mr. Smith said he was very pleased to see so many young men present, and he trusted it might be taken as a sign of the times so far as Halifax was concerned.

The Paper will be dealt with in a future issue.

Small Bessemer Plants.

The advantages of small Bessemer plants as independent steel works, and also as additions to already existing foundries, are well known, a number of plants of this kind having been for some time in operation in this country and abroad. The low cost of installation of the system, its adaptability to existing plants, its simplicity and easy manipulation, the small loss of material and consumption of fuel it involves, its short period of operation with highest temperature, together with a wide range of production, are the advantages claimed for it.

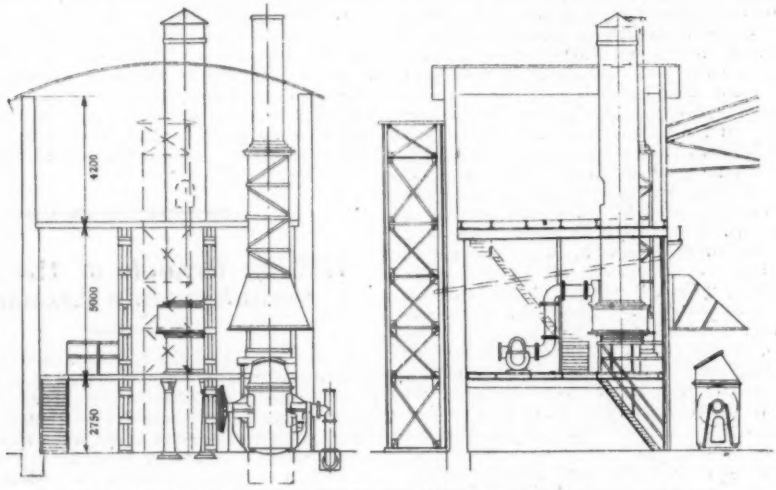


FIG. 1.—SMALL BESSEMER CONVERTER STEEL PLANT; FRONT AND SIDE SECTIONAL ELEVATIONS.

In view of this some account of the working of this form of plant may be of interest. To begin with, it is impossible to manufacture hot steel in the converter unless the pig-iron is properly fluid. It is therefore necessary to have a good cupola directly-connected with the converter, while for daily melting two cupolas are necessary. For ordinary purposes the converter is of similar construction to the Tropenas converter, and is capable of taking up a charge of 18 to 25 cwts. It is provided with a mechanism for tipping by hand, this consisting of a worm and worm wheel, which may also be worked by electric power, where this is available. The blow for a 1-ton charge takes 12 to 15 minutes, and the pouring 10 to 20 minutes, according to the size of the castings; therefore, in 10 hours 15 to 20 charges can be produced. The temperature of the steel is so great that it is quite possible to pour different charges for one casting up to three tons weight. If many heavy pieces have to be cast, the 18 to 25 cwts. converter can be supplemented by a second converter, say of 24 to 32 cwts. capacity, so that the small and the large converters can be used alternately.

The blower for the converter must have reserve capacity, and can be worked either by belt transmission or by direct-coupling to a steam engine or electric motor. The consumption of power involved is 70 to 80 h.p.

The figures relating to cost of production, as given herewith, have been obtained from German practice, and may be improved upon if the prices of material and local conditions are favourable. If, for instance, on the days when steel is manufactured the cupola is used also for the melting of cast iron, the expenses for coke, melters, and unskilled labourers are reduced.

The cost of producing steel castings is chiefly influenced by the rate of wages, the cost of raw material, and the quantity produced. The following estimate, by A. Zenzes, is based on an output of 10 tons of castings per week, five charges of about 1 ton each being treated every other day, making 15 charges a week:—

RAW MATERIALS.

	£	s.	d
10.5 tons of hematite pig at £4	42	0	0
4.5 steel scrap at £3	13	10	0
15 tons charge for cupola	55	10	0
2.7 tons for 18 per cent. loss in cupola and converter.			
12.3 tons of finished steel in converter.			
1.1 ton coke for heating cupola furnace 3 times.			
1.1 ton coke for heating converter and ladles.			
1.5 ton 10 per cent. coke for melting.			
3.7 tons of coke at 24s.	4	8	10
0.3 ton of limestone	0	5	0
0.615 ton pig-iron, 0.125 ton ferro-manganese — additions to charge	2	15	4
	1	5	0
13.040 tons of molten steel in the casting ladle at £4 15s. per ton.	64	4	2
3.040 tons deducted for casting waste	9	2	5
10 tons of steel as castings	55	1	9
Add:			
Cost of power for converter blast	1	10	0
,, ,, cupola	0	7	6
Repairs to cupola and converter	1	5	0
Wages of foreman and labourers	10	0	0
	68	4	3
Total cost of steel in castings, per ton	6	16	6

WAGES, MOULDS, MOULDING SAND, ETC., PER TON OF CASTINGS.

	£	s.	d
Moulders' wages, including cores	3	0	0
Cleaning moulds	0	15	0
Extra labour in foundry	0	10	0
Drying and heating	0	10	0
Moulds, sand, composition	0	5	0
Trimming castings	0	15	0
	£5	15	0

GENERAL EXPENSES, ON A CAPITAL OF £2,000.

	£
10 per cent. depreciation	200
5 per cent. interest	100
Working expenses per annum	500
Salaries, waster castings, etc.	500
	£1,300

Equivalent to £2 10s. per ton of castings.

The foregoing estimates show a cost in round figures of £15 per ton of castings, which cost would, of course, be considerably lower for a larger output.

When business is slack, users of open-hearth plant have to reckon with a very considerable outlay for refractory material, wages and fuel, whilst in busy times they are dependent on a supply of cheap raw material, namely, scrap. The small converter plant, on the other hand, has always had to use expensive hematite pig, the consumption of scrap being restricted to about 30 per cent., or at most 40 per cent., of the charge.

The Converter for Cast-Iron.

The converter system has of late years been adopted by various large makers of malleable castings in Germany, using cheaper material than hematite pig. Castings of similar quality and composition to the American "black heart" are said to be made in the converter, though not in the cupola furnace; and as it only requires a short blow, the dross and the wear of the converter are reduced to a minimum, so that the process gives cheaper metal than that produced by direct melting in the cupola or the reverberatory furnace. The application of the small converter to the production of malleable castings opens a wide field to users of these small plants. The small converter may also be employed for making cast iron of high breaking strength. The method consists in mixing white iron that has been blown to a high temperature in the converter, with molten pig, the resulting metal possessing, in consequence of the chemical reaction, a temperature that is unattainable by any kind of cupola cast-iron. The high temperature of production of this special grey iron—the characteristic composition of which is 2-3 per cent. carbon, 1-2 per cent. silicon, and less than 0.5 per cent. manganese—also gives it excellent physical properties. The cost of production is about £1 per ton more than that of good cupola iron. When the production of large quantities is in question, the charge may consist of cheap pig and grey scrap, since the limit of 0.1 per cent. of phosphorus, requisite in the case of steel castings, need not be adhered to.

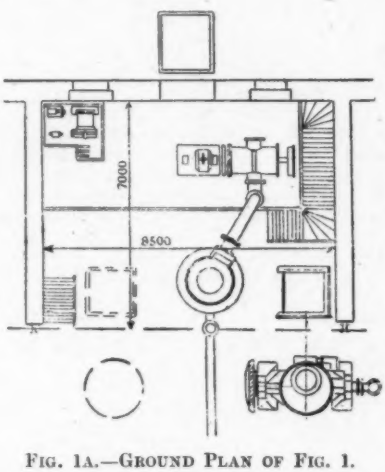


FIG. 1A.—GROUND PLAN OF FIG. 1.

In the continuous manufacturing of steel castings, where converter grey castings are produced as a by-product only, the following figures have been obtained:—

MATERIALS CHARGED.

Cwts.		£	s.	d.
210	Hematite pig-iron at 75s. per ton	39	7	6
90	Steel scrap at 50s. per ton	11	5	0
300	Charge	50	12	6
44	15 per cent. coke for melting at 25s.	2	16	3
		53	8	9
15	= 5 per cent. loss in the cupola.			
17	= 12 ,, ,, ,, converter.			
32	total loss.			
28	(about 10 per cent.) dead-heads at 50s... ...	3	10	0
60				
240	of saleable castings ... ... (or 4s. 2d. per cwt.)	49	18	0

WAGES, REFRACTORY MATERIAL, SAND, ETC.

	s.	d.
Wages for moulders and core makers per piece ...	2	3
,, ,, melters	0	6
,, ,, dressers	0	3
,, ,, unskilled labourers in foundry	0	7½
Refractory material and sand	0	6
Power for converter blower	0	1½
	4	3

SUMMARY.

	s.	d.
1 cwt. of saleable castings	4	2
Wages, refractory material, etc.	4	3
General expenses...	0	9
Royalty	0	6
Total cost per cwt. of converter cast iron (grey metal)	9	8

Small Bessemer Plants in Conjunction with Open Hearth Furnaces.

Open-hearth steel works have also begun to recognise the utility of a well-constructed small Bessemer plant as a complement to their plants; the fact of a converter being able to supply every 40 minutes a charge of any required quality and composition is not only advantageous for casting small thin articles, but by gathering several charges in a larger ladle moderately heavy castings can also be obtained, and by adding metal successively from several large ladles even heavy and thick castings are possible.

The open-hearth furnace can only supply one heavy charge of a certain quality. It happens, therefore, that the required quality of the castings cannot always be exactly produced. The small Bessemer converter, on the contrary, not only allows the manufacture of every required quality, but it is also possible by means of fluxing and re-carburation in the ladle, to obtain from a charge of soft dynamo castings smaller quantities of harder steel, without interfering with the fluidity of the very hot metal in the converter.

Another advantage claimed is the supplementing of the open-hearth furnace when casting heavy pieces of thick section. An open-hearth furnace can be used only at the sacrifice of its durability and melting capacity for the manufacture of such castings.

The waste and loss of a small Bessemer plant, according to the qualities of steel manufactured, amount to 18 to 20 per cent. But owing to the high temperature of the metal it is possible to melt again part of the red-hot heads of the previous casts and to produce 90 per cent. and more of liquid steel of the charge in the cupola. At a large steel foundry where one of these small Bessemer plants with

two converters has been working for some time, the following results have been obtained :—

		Cwts.	£	s.	d.
Charge of cupola and converter		400			
Output, 12 charges of 27 cwt.		342			
Loss and waste in cupola and converter (19 per cent).		76			
Cwt.			£	s.	d.
340 Pig-iron at 70s.			59	10	0
54 Steel scrap at 50s.			6	15	0
6 { Ferro-manganese at 175s. / Ferro-silicon at 100s. }			2	12	0
48 12 per cent. coke for cupola furnace / 10 Coke for heating converter }	22s.		3	3	9
400 Charge			72	0	9
Electric power for converter (2s. 6d. per charge)			1	10	0
,, ,, cupola			0	6	0
Repairing of converter			1	6	0
Wages: 1 Foreman			0	10	0
1 Melter for cupola			0	5	0
1 Workman			0	4	0
2 ,, for converter			0	8	0
1 ,, ,, unskilled labour			0	3	0
1 ,, ,, striker			0	4	0
2 Men for carrying iron			0	8	0
1 Man for carrying coke			0	4	0
1 Engineer			0	4	0
1 Bricklayer			0	4	0
5 per cent. interest and 10 per cent. amortisation on 2,000 charges			2	5	0
			80	1	9
321 cwts. of molten steel cost (or 5s. per cwt. in the ladle).			80	0	0

In the steel works referred to, generally up to 15 charges per day of 27 to 30 cwts. are blown. Such large production is only possible with a system which guarantees a relatively short period of blowing and a short time for preparing the castings.

Small Converter Installations.

The drawings, Figs. 1 and 2, illustrate possible methods of arranging a small converter plant, either as a separate installation for turning out large or small quantities, or as an appendage to an existing foundry. The cupola furnace may either be put up on the ground floor, the pig ladle being slung on a crane and tipped by this means into the tilted converter, or else it may be mounted on a raised stage, from whence the molten pig may be run through a trough direct into the upright converter. It follows, therefore, that the cost of erecting a small converter plant will vary considerably, according to local conditions. In a well-equipped iron foundry, where the blower can be driven from shafting, a complete plant can be set up for less than £500; whereas erecting the plant as a separate establishment may run into £12,000 or more. Any cupola furnace of sufficient size, and capable of furnishing molten pig will do, preference being given to one without a fore-hearth, but with a bed large enough to hold the necessary quantity for a steel charge. For special purposes it is sometimes advisable to mount the cupola on a high stage, the molten iron being run down a trough into the converter, whilst a second tapping device serves for supplying the iron for ordinary grey castings. This enables the furnace to be utilised most advantageously, the hematite charge for the converter being melted in the morning, and the charge for the ordinary grey iron castings in the afternoon.

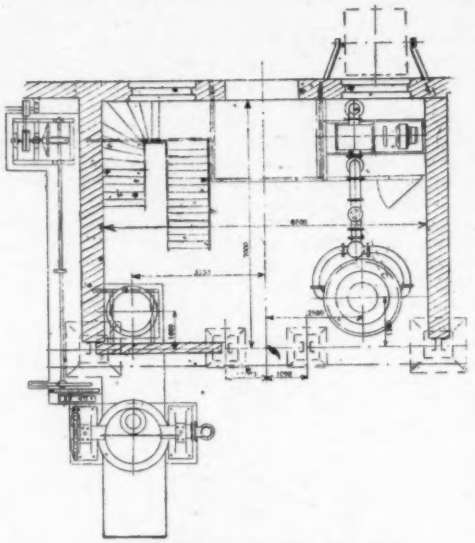


FIG. 2A.—GROUND PLAN OF FIG. 2.

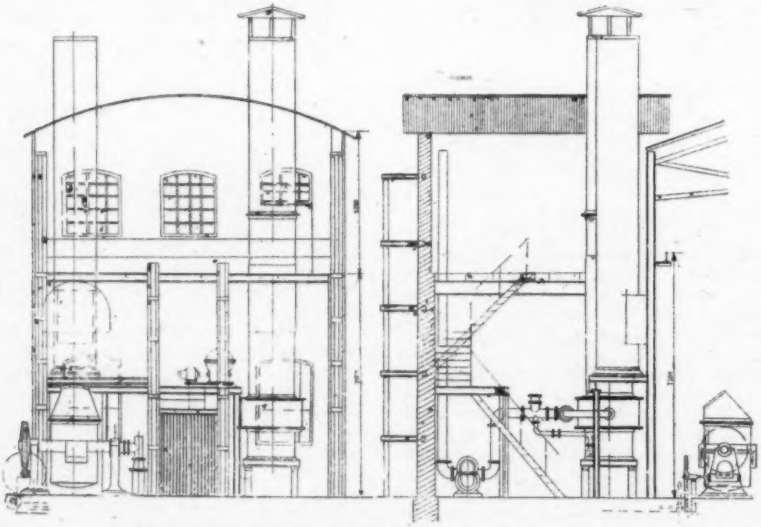


FIG. 2.—SMALL BESSEMER CONVERTER STEEL PLANT.

The construction of the converter differs, according as it is intended to hold a charge of half a ton or one of three tons, and depends in all cases on the purpose in view and on the local conditions. A suitable form of construction of small converters is illustrated in Fig. 3. This converter is arranged to be tilted by hand, a coupling being also provided for connecting it with any source of power. The converter and driving mechanism are fitted with ball or roller bearings, and by using a special type of nozzle, the jacket, which is suspended in the cast-iron ring and fastened with bolts, can be easily taken out and replaced by a new one. Moreover, this system enables a small (1-ton) converter to be used in a new plant, fitted with a large ring, and afterwards replaced by a 1½-2-ton converter as the business increases or larger charges are required. The blow for a 1-ton charge takes 12 to 15 minutes, and the pouring 10 to 20 minutes, according to the size of the castings, so that 15 to 20 charges can be cast in a 10-hours shift. The blower is operated either from a shafting, or coupled direct to a steam engine or electric motor. The amount of power consumed by the blower varies from about 40 h.p. for charges up to 1 ton, to 100 h.p. for charges up to 3 tons.

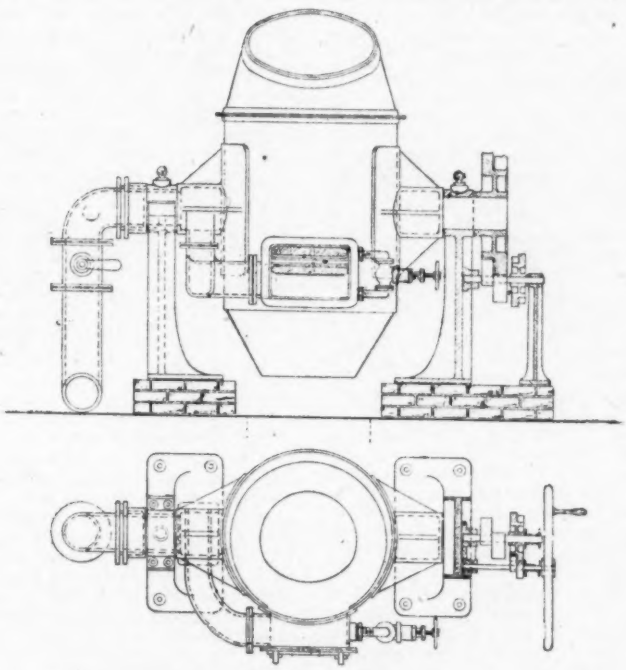


FIG. 3.—PLAN AND ELEVATION OF THE GEBAUER-ZENZES SMALL BESSEMER CONVERTER.

It would be wrong to assume, however, that the small Bessemer process is perfect, and as adaptable as iron founding. On the contrary, it is only in the hands of a skilled technical operator that it will furnish good products; and it is well known in the trade that bad management leads to highly disagreeable results. There is still a wide field open for improvement in connection with the small converter process; and the finest prospect for the future of the process will probably be found in a combination of the converter and the electric furnace. Steel produced by the acid Bessemer process inevitably is not of the first quality as regards chemical composition, since the phosphorus and sulphur cannot be eliminated, and the percentage of these inimical constituents is determined by the raw material used. By the use of a 1-ton converter, in conjunction with a 1-ton electric furnace, a charge can be got ready in the converter every hour, each alternate charge being refined in the electric furnace for high-quality castings, the other charges being used for ordinary steel castings. A ton of mild converter metal can be refined in the electric induction furnace in less than two hours, and almost entirely freed from phosphorus and sulphur, with a consumption of about 300 kw. of current. Assuming work to be carried on without interruption, the cost of refining a ton of steel in the electric furnace will be about £1—a small sum when metal of excellent quality is in question. With a small residual charge, the electric furnace can be left under current for several hours without injury to itself, so that continuous working is not indispensable. When molten steel from the converter is not available, the furnace can be charged with solid material, though in such case about 900 kw. will be consumed per ton, so that the cost of production works out rather higher. The furnace fittings will last for about 50 charges, and if the corresponding quantity of refined steel be turned out every week, together with 50 charges of ordinary converter steel, the yearly output will amount to 2,500—3,000 tons. Moreover, as continuous working is not essential, success can be attained with a smaller output.

THE KITSON EMPIRE LIGHTING COMPANY, LIMITED, Stamford, have adopted "Kelite" as their new trade mark, which will in future be stamped on their lamps and spare parts.

Cupola Linings, Fluxes, and Slags.

The Effect of Limestone on Cast Iron.

By M. Albuetz.

(*Continued from page 595.*)

The amount and quality of limestone are, in a good many foundries, items of secondary importance, and far too few experiments take place in this direction; and especially so, since it must be recognised that lime is found with a great variety of chemical compositions. Limestone, as was illustrated in the previous article, is used in cupola melting as an agent to form an easy-fluxing slag with the coke ash, the sand and dirt charged with the iron into the cupola and oxides of iron, silicon and manganese. If lime combines with these impurities at a sufficiently high temperature, the slag accumulating in the cupola during the melting process becomes more easily fluid than without the use of lime, and as it is necessary to have the accumulated slag removed from the furnace, it is also necessary to charge the required amount of lime in approximate proportion to the amount of impurities which require fluxing, granted, of course, that the melting conditions are as nearly regular as possible and the chemical composition of the lining used for each heat remains approximately the same. Further, it has also been pointed out that the amount of lime greatly depends on its own chemical composition, namely, the purer it is, the more actual lime there is present, and consequently the greater the chemical efficiency of the lime; with the same quantity more coke ash and sand will be fluxed and at the same time less heat will be required to bring a smaller quantity of lime to a certain temperature. It has also been demonstrated that lime containing a large amount of impurities such as silica, and very often alumina, is of less value, because silica and alumina (supposing the latter acts as an acid) require a certain percentage of lime to be fluxed, therefore the lime is less efficient and a greater amount would be required for a certain unit of iron melted.

The addition of lime in cupola melting has, of course, not only its sole purpose in fluxing and assisting the easy removal of slag from the cupola at certain intervals; another object is to remove a certain percentage of sulphur, which is always more or less present in pig-iron and coke. The coke used for melting purposes may contain from 0.50 to 1.25 of sulphur. Suppose that one-half of this amount escapes with the gases and the other half is imparted to the molten metal, then the iron after having been melted once would contain from 0.025 per cent. to 0.065 per cent. more sulphur than the iron charged. In every mixture, however, there will be a large percentage made up of shop scrap, such as waste castings, runners, and risers. A certain percentage of each charge, therefore, will be remelted again several times, whilst during each melting process the iron will absorb a certain quantity of sulphur, and the latter can thus reach such a high percentage that certain precautions become necessary to guard against producing an inferior quality of cast iron. This would invariably be the case at the beginning of each heat, because the descending drops of molten metal have to pass from the melting zone downwards through the coke-bed, and therefore have ample opportunity to absorb a certain quantity of sulphur, which must, as far as possible, be avoided. An illustration is given below in regard to the effect and behaviour of limestone on cast iron during the melting process and the subsequent effects on cast iron itself.

The following example gives an interesting proof of the fact that the quality of limestone used in cupola melting can be of far-reaching consequences, and this fact should no longer be ignored by the great number of foundrymen who have up till now considered this question as a mere detail.*

The cupola used in connection with the trial tests had an inside diameter of 40 in., and the thickness of the lining increased near the tuyeres to an internal diameter of 30 in.; the cupola being provided with two rows of tuyeres, the lower with 100 sq. in. and the upper with 60 sq. in., or a total area of 160 sq. in. The receiver attached to the cupola held about 4 tons of molten metal. The pressure of the blast remained the same over the whole of the series of trials, namely, 14 ozs. = 22 in. w.g. The coke used contained 8.7 per cent. ash and 1.3 per cent. sulphur, and must, therefore, be considered rather below the average quality. The limestone originated from the Swiss Jura, and had the following composition :—

	Per cent
SiO_2	3.05
Fe_2O_3 and Al_2O_3	4.12
CaO	51.12
CO_2	40.80

The charges were made up of 10 cwts. of iron and 66 lbs. of coke each. Greatest care was taken to maintain the melting condition as uniformly as possible, and with the only difference, as will be seen later, that the limestone in every successive heat was in equal proportions increased. The quantity of iron melted each heat was likewise kept within the same figures as far as circumstances would permit and averaged from 15 to 20 tons.

The iron charges were made up in the following proportions :—

Harrington No. IV.	2 cwt.
Harrington No. III.	1 cwt.
Alabama No. IV.	2 cwt.
Shop scrap of the above	5 cwt.
Total	10 cwt.

Composition of the above iron : —

	Si. Per cent.	Mn. Per cent.	P. Per cent.	S. Per cent.
Harrington No. III...	2.38	0.12	0.07	0.02
Harrington No. IV...	1.45	0.12	0.04	0.05
Alabama No. IV...	2.83	0.43	0.91	0.04

Heat No. 1 was melted without the use of any limestone whatever. Then, in every successive heat the limestone was increased by 1 kg. = 2.2 lbs., until it had reached in the eleventh heat to 22 lbs. The slag accumulating in the receiver was tapped off

* The figures and compilation of the example have been given by kind permission of F. Wuest, D.Met., Technical High-School at Aix-la-Chapelle, and the experiments were carried out at the famous Engineering Works of Sulzer Bros., Winterthur (Switzerland).

and ran into a sand bed. During each of the eleven heats the weight of the slag produced was carefully recorded, and an average sample analysed. Samples of molten metal from every heat were also analysed, and accurate and extensive trials with test bars undertaken.

The metal of the ten successive heats had the following composition :—

TABLE I.—*Composition of Metals.*

		1	2	3	4	5	6	7	8	9	10
Quantity of limestone used per charge in lbs.	0	2.2	4.4	6.6	8.8	11.0	13.2	15.4	17.6	19.8	22.0
Percentage of limestone used per coke charge	0	3.3 Per cent.	6.6 Per cent.	10.0 Per cent.	13.3 Per cent.	16.6 Per cent.	20.0 Per cent.	23 3 Per cent.	26.6 Per cent.	30.0 Per cent.	33.3 Per cent.
Silicon	1.44	1.50	1.70	1.78	1 61	1.56	1.75	1.57	1.38	1.48	1.57
Manganese	0.35	0.38	0.37	0.39	0.40	0.35	0.37	0-41	0.61	0.37	0.39
Phosphorus	0.48	0.51	0.50	0.54	0.43	0.35	0.54	0.53	0.69	0.49	0.54
Sulphur	0.128	0.156	0.133	0.140	0.114	0.101	0.116	0.102	0.088	0.085	0.100

The figures clearly prove that the percentage of sulphur in molten metal very largely depends on the amount of limestone charged. As the quantity of limestone increases, the percentage of sulphur in the molten metal will decrease, as in the above table, from 0.156 per cent. down to 0.085, or a decrease of nearly 44 per cent.

The percentage of manganese in cast iron is generally low and little affected by oxidation, whilst the latter acts more speedily on silicon, which fact is the chief explanation of the continuous variation of the silicon contents in every successive heat. By far the greater variation is found in the contents of silicon, whilst the percentage of manganese and phosphorus, with the exception of series No. 8, remains much the same. This last-named case shows at the same time an abnormally low percentage of silicon. It is, however, very likely that in spite of all the care exercised during the tests, shop scrap of some other mixture, perhaps runners from cylinder castings, unfortunately found its way into the heat No. 8, which would easily explain the high percentage of manganese and the low silicon content. From the above figures will therefore readily be recognised the great difficulty, although using the same mixture of metal, in obtaining castings of approximately the same composition, but cast at different times.

The cupola slag had the following composition :—

An examination of this diagram will show that by increasing the amount of limestone the percentage of lime or calcium oxide in the slag will also, although not with absolute regularity, gradually be increased, and this, in turn, effects the likewise gradual decrease of the silica. A similar decrease of the iron oxide will be noted, and exactly the same course, but with more irregularity, is taken by oxide of manganese. This variation is chiefly due to the unavoidable changes of the melting process, and especially so if the temperature in the cupola begins to vary.

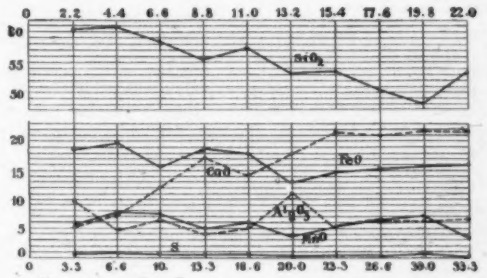


FIG. 4.—LIMESTONE IN PER CENT. PER COKE CHARGE.

Alumina shows a sudden change from Series No. 5 to No. 7, and the reason thereof is more than likely a higher temperature, causing the melting away of the lining (consisting of silicate of alumina) to a greater extent than under usual conditions.

Somewhat surprising is the irregularity of change as regards sulphur. Theoretically, considering the laws of chemistry, it is natural that cupola slag should have a greater affinity towards the absorption of sulphur, the greater the quantities of oxide of lime and oxide of manganese such slag contains; generally speaking, one would suppose that with an increase of sulphur in the slag, silica should in a proportional degree decrease. In comparing the above table, however, it will be seen that in this respect there exists no direct connection. Slag No. 2 represents by far the highest percentage of sulphur and silica, whilst in No. 8, in spite of the low silica

TABLE II.—*Composition of Slag.*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Quantity of limestone used per charge in lbs. ...	2.2	4.4	6.6	8.8	11.0	13.2	15.4	17.6	19.8	22.0
Percentage of limestone used per coke charge ...	3.3 Per cent.	6.6 Per cent.	10.0 Per cent.	13.3 Per cent.	16.6 Per cent.	20.0 Per cent.	23.3 Per cent.	26 6 Per cent.	30.0 Per cent.	33.0 Per cent.
Silica	60.60	60.95	58.60	55.10	75.10	53.20	53.50	50.40	48.80	53.20
Alumina	9.83	4.50	6.56	4.0	4.80	10.80	5.10	6.46	6.46	6.77
Oxide of iron	18.51	19.70	15.40	18.25	18 05	12.80	14.70	15.17	15.43	15.68
Oxide of manganese	5.25	7.30	7.35	4.80	5.80	3.45	5.12	6.40	6.97	3.15
Lime	5.20	7.20	11.95	17.0	14.20	17.20	21.40	20.80	21.60	21.60
Sulphur...	0 45	0.98	0.52	0.74	0.87	0.51	0.63	0.40	0.81	0.31

Slag No. 1 was of a rather stiff and pasty consistency, and when cooled down had a spongy appearance. No. 3 showed a still somewhat semi-fluid condition, but after cooling it was solid, compact, though somewhat brittle. Nos. 4 and 5 were more fluid, and when cooled down were less brittle than No. 3. Nos. 6 to 10 were all very fluid, solid, compact, and rather difficult to break up. The colour of the slag No. 1 was light-greenish, and gradually changed to brown, then darker, and, finally, in No. 10 it was black.

The chemical composition of slag from the whole of the ten heats is given in diagram, Fig. 4.

contents, the same slag has absorbed less sulphur. From the foregoing table, it will also be seen that no direct relation exists between the oxide of manganese and sulphur contents of any slag.

It must, however, be understood, that apart from the chemical composition of the slag, the absorption of sulphur from the charges is governed by various other circumstances, such as the temperature and fluidity of the slag. The higher the temperature, the more fluid the slag is.

bars were moulded in a box and cast on an incline, the latter being about 20 per cent. of the total length of the bars. The runner was placed at the lower level, and a riser provided at the top end. The moulds were then brought into the drying stove. By every one of the eleven trials, four bars were produced, and the average figure resulting from the tests recorded. The bars for the transverse tests had a length of 1 metre between the supports, and the sides measured 30 mm. by 30 mm.; the bars were tested

TABLE III.—*Quantity of Slag and Amount of Metal Oxidised.*

——	—	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Quantity of limestone used per charge in lbs.	—	2.2	4.4	6.6	8.8	11.0	13.2	15.4	17.6	19.8	22.0
Weight of slag per ton of iron in lbs.	50	66	64	123	128	140	132	165	176	178	179
Quantity of iron in per cent.	—	14.4	15.3	14.9	14.2	14.0	9.90	11.4	11.8	12.0	12.2
Quantity of Mn. in per cent.	—	4.07	5.66	5.70	3.72	4.50	2.67	4.0	4.96	5.42	2.44
Melting loss of iron in lbs. per ton	—	8.9	9.2	8.9	13.0	17.0	17.2	17 5	21.7	21.9	22.0
Melting loss of Mn. in lbs. per ton	—	2.5	3.4	4.3	4.6	5.9	3 6	5.4	8.3	9.0	4.10
Melting loss of Si. in lbs. per ton	—	4.6	5.2	5.5	4.8	4 6	5.2	4.6	4.1	4.3	4.6
Total melting loss in lbs. per ton	—	16.0	17.8	18.7	22 4	27.5	26.0	27.5	34.1	35 2	30.7
Total melting loss in per cent....		0.78	0.86	0.91	1.25	1.30	1.06	1.30	1.54	1.62	1.42

Table III. gives some information regarding the quantities of slag and the amount of metal oxidised. The amount of slag varies from 66 lbs. to 179 lbs. per ton of iron charged. From the analysis of the cupola slag and the total weight of same, the oxidation of iron and manganese is calculated. The lowest percentage of iron oxidised is 0.43, whilst the maximum reaches 0.98 by gradually increasing in proportion to the increase of the weight of the slag, respectively to the increase of limestone. The oxidation of manganese ranges between 0.12 per cent. and

FIG. 5.

0.437 per cent. This increase, however, does not occur gradually, but is more or less irregular, for reasons given above. The oxidation of silicon is determined by calculations, and after prolonged and careful experiments fixed at 15 per cent. of the silicon contained in the molten metal. By summarising the oxidations of iron, manganese, and silicon, the total amount of metal oxidised, or the melting losses, are easily obtained, and according to the above table, range from 16.0 to 35.2 lbs. per ton of iron

without previously being machined. Deflection was recorded likewise. Portions of these test bars, after

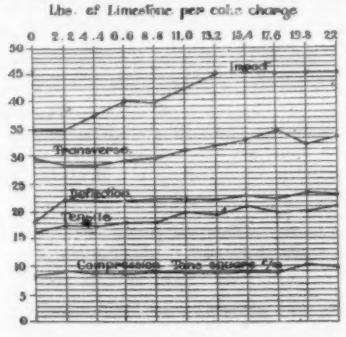


FIG. 6.—RESULTS OF TESTS OF THE METAL.

Transverse test in kg. per sq. mm. (Bar 40 in. × 1½ in. × 1½ in.
Deflection in mms. ... ...
Tensile test in kg. per sq. mm. (See Figure 5.)
Impact test in cm. ... ... (Drop of weight.)
Compression test in tons per sq. cm.

being broken as the result of the transverse test, were then machined and worked down to the size and shape shown in Fig. 5. Here, again, the figures given in the above table are an average of

TABLE IV.—*Results of Tests on the Metal.*

——		1	2	3	4	5	6	7	8	9	10
Limestone in per cent. of coke charged	0	3.3	6.6	10.0	13 3	16.6	20.0	23.3	26.6	30.0	33.3
Transverse tests in kg. per sq. mm.	27.9	28 5	28.7	29 3	29.5	31.2	32.0	32.8	34.3	32 5	33.5
Deflection in mm. (40 in. bar)	18.6	22.5	22.5	22 5	22.5	22 5	22 5	23.0	22.5	23.5	24.2
Tensile tests, kg. per sq. mm....	16.8	17.3	17 6	18.3	18 3	20.3	19 8	21.2	20 1	20.5	21.2
Impact tests - drop in cm.	35.0	35.0	37.5	40.0	40.0	42 5	45.0	45 0	45.0	45.0	45.0
Compression tests per sq. cm....	8.6	9 2	8,9	8.8	8.9	8.8	9.3	9.0	9.0	10.2	9.9

charged. The amount of this oxidation stands in direct proportion to the total amount of slag per heat, respective to the amount of limestone charged.

Melting losses, mentioned from time to time, have been as high as 5 per cent. of the metal charged, and, therefore, excessive; in this particular instance the total melting loss varies between 0.8 per cent. and 1.6 per cent. only.

The test bars used for making transverse tests were obtained in the following manner:—Two test

four bars tested. The impact tests were made with square pieces, 40 mm. by 40 mm. and 160 mm. between supports. The weight of the hammer was 12 kgs. The tests began with a 30-cm. drop, and the latter, after each fall, increased by 10 cm., until fracture occurred. Here, again, at each trial of the same heat four bars were tested and the average taken.

The compression tests were made at the Swiss Federated Testing Institute and the samples were

30 mm. cubes taken from the fractured pieces of the transverse bars. The results of these tests are shown in the diagram, Fig. 6, and it will be seen the figures here obtained gradually increase as the amount of limestone increases, until the latter amounts to about 20 per cent. of the coke charged.

The transverse tests show a similar increase as the amount of limestone increases and the maximum strength is reached at 26.6 per cent. Deflection seems to be very slightly effected. Tensile and impact tests show a steady increase in strength until the limestone charge amounts to about one-fifth of the coke charge. The various test curves on the diagram are given in the metric system, as indicated in the inscription.

A mere glance at Fig. 6 will distinctly confirm all that has been said previously as regards the value of limestone if used reasonably and in proportion during the process of melting.

Electric Furnace for Melting Ferro-Manganese.*

Owing to the losses and inconveniences arising from the addition of solid ferro-manganese to steel charges, many steel makers adopted the practice of melting the ferro-manganese in a crucible. This method, however, proved too costly, in consequence of the vapourisation of the manganese, until the idea arose of employing the electric furnace for that purpose, and the experiments made by Keller demonstrated its applicability. A Keller furnace has been installed at the Burbach Works, where it is used both for steel-making and for remelting ferro-manganese, over 1,000 tons having been treated, in the intervals of using the furnace for making steel, during the past nine months. When ferro-manganese is being melted, the furnace works continuously, being kept warm over Sundays with a low consumption of current. Any repairs that are found necessary can be executed after pouring the contents of the furnace into a ladle, to be returned when the job is completed. The replacement of the electrode is quickly effected, the worn-out electrode being lifted out by a swing jib, and the new one lowered into position by a second jib of similar character.

The behaviour of the lining is an important factor in the cost of re-melting ferro-manganese; but in this furnace work has been carried on for three months at a time before re-lining became necessary, although the acid lining of the vault was already worn out in working previous steel charges. Even the dolomite lining only needed occasional patching. A still longer life could be ensured by using magnesite lining, which would last, as in the pig-iron mixer, from six to nine months. The sloping bottom lining only needed occasional patching, and the hearth also stood the nine months' continuous work, the bars neither melting nor being converted into ferro-manganese.

The furnace is started by simply lowering the electrode on to the solid charge of ferro-manganese, without it being first necessary to pour any pig-iron or steel into the furnace—this measure, recommended by some, being inconvenient and, to some extent, impracticable, since basic iron is unsuitable on account of its high phosphorus content, whilst steel is not often available at the time when the furnace is generally started (Sunday night). Little attention is required, one man and a boy being able to run the furnace. The most convenient place to set up the furnace is on the platform of the converter, so that the molten ferro-manganese can be easily transferred in ladles. The furnace is tilted by a hydraulic machine connected with the power plant of the converters.

The experience gained at the Burbach Works goes to show that there is no loss of manganese by vapourisation in the Keller furnace. The average manganese content of ten charges of solid ferro-manganese, before melting in the furnace, was found by analysis to be 80.29 per cent. whilst the mean of 37 samples of molten ferro-manganese drawn from the furnace was 80.22 per cent. of manganese, the loss being therefore infinitesimal. Although, owing to local circumstances, the charges at the Burbach Works require to be considerably overheated, no red fumes are given off to inconvenience the furnace hands. It is found that by using the ferro-manganese in molten condition a saving of 35 per cent. is obtained by comparison with solid ferro-manganese, the same quality of steel being produced. Another saving arises from the fact that the ferro-manganese dust produced in crushing the lump material, or during storage, can also be melted in the furnace with ease.

With current at ½d. per kw.-hour, the cost of melting the ferro-manganese works out at 20s. per ton, including current, cost of electrodes, wages, lining and repairs. Even with the present low price of ferro-manganese (£8 per ton), each 1 lb. of ferro-manganese saved in a ton of steel is equivalent to a saving of £400 per annum on an output of 100,000 tons of steel; and so on in proportion.

When molten ferro-manganese is used, the desired quality of steel can be obtained with greater certainty than by the aid of solid material. In the latter case, losses in the converter are inevitable; whereas, by adding molten ferro-manganese to the steel in the ladle, it is completely absorbed by the metal, more especially since the slag can be kept back, by stiffening it with lime, before the steel is run into the ladle. By examining a sample after blowing, a reliable estimate can soon be obtained of the amount of ferro-manganese needed to produce steel of a given quality; and this circumstance is particularly valuable when large additions of ferro-manganese are given in order to produce hard metal. On the other hand, if solid ferro-manganese be added in the converter, there is always the risk that it will not be melted in time, particularly in the case of cold charges, etc. This cannot occur with molten ferro-manganese, and red-shortness is therefore practically impossible. The absorption of the manganese also proceeds more uniformly, the mixing being more complete, deoxidisation is more energetic, and re-phosphorisation is precluded. Finally, a saving of time is effected by using molten material, the output of steel being, therefore, correspondingly increased.

* F. Schroeder in "Stahl und Eisen."

A Large Shockless Jar-Ramming Moulding Machine.

One of the largest jar-ramming moulding machines ever constructed, and certainly the largest of the shockless type, has recently been built by the Tabor Manufacturing Company, of Philadelphia, U.S.A. The machine is equipped with a steel table, 8 ft. by 12 ft., with cylinder attached, 36 in. in diameter. It is mounted upon a plunger base of cast iron, weighing about 65,000 lbs. The plunger base is fitted in the cylinder base, 5 ft. in diameter, and rests upon 22 helical steel springs. The total weight of the machine is approaching 100,000 lbs. The machine is designed to ram moulds from 6 ft. to 8 ft. wide and 12 ft. to 18 ft. long the weights ranging up to the rated capacity of 50,000 lbs.

Oil-Fuel for Non-Ferrous Metal Smelting and Refining.

Its Application by the Tandem Smelting Syndicate.

From the comparatively crude metallurgical methods that were in vogue a few years back, there have evolved a number of highly efficient processes, employing as fuels, coal, coke, gas, oil and electricity. Each has, in its own field, recorded considerable success, but the use of oil-fuel has, in this country, at least, not been very largely adopted. It is interesting, therefore, to find a modern concern within 10 miles of London, operating with oil-fuel with conspicuous success. Such is the case with the Tandem Smelting Syndicate, Limited, who formerly were established in Southwark, but who have during the last two or three years erected and conducted smelting works at Merton Abbey, Surrey, which are in many respects unique.

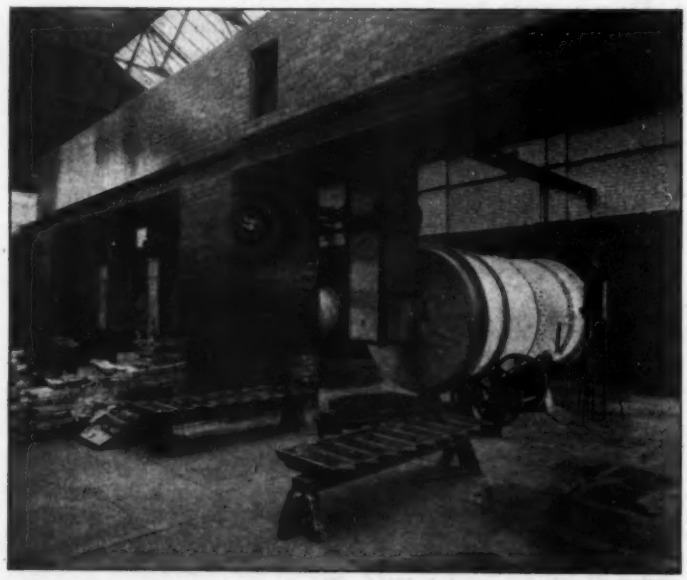


FIG. 1.—NEW TANDEM ROTARY FURNACE, FIRED BY HÖHELER LIQUID-FUEL BURNER.

Merton Abbey Works.

The present works, comprising a fine suite of offices and laboratories, and a number of imposing buildings, occupy several acres of ground in close proximity to the railway line (a joint branch of the London & South Western Railway, and the London, Brighton & South Coast Railway), and are served by private sidings for the reception and despatch of materials.

The offices for the commercial staff are spacious and well arranged, and in the same building are large, well-equipped laboratories for the sampling and analyses of the raw materials (mostly tin- and lead-bearing ores), and the Tandem alloys for anti-friction and other purposes in which the Company specialise. Copper, antimony and phosphorus also enter into various of the alloys produced, but tin is the most important of the metals employed. Since the Company are not only mixers of alloys, but also smelters, the raw material includes ore concentrates of tin, lead, antimony, etc., which are reduced and refined in the various furnaces, and then alloyed as desired. The works themselves are a model of cleanliness and convenient arrangement. The spacious buildings in which the different furnaces are housed are paved with iron plates, and the walls are constructed with glazed bricks, of brown colour up to about 10 ft. high and white above that point. The result is a number of shops of a particularly light and clean character. Electricity generated at the works is used as an illuminant when necessary. A system of trolley trucks enables the ores and ingot metal to be easily handled and moved from point to point as required. In the engine-room is a 50-h.p. gas engine driving the air compressors for the supply of compressed air used in the oil-firing, and a pump for drawing the water supply for the works from the Company's own well. Over the section of the works where the engine-house is situated on the ground floor, is constructed a large tank for water storage.

The furnaces used in the different processes comprise both rotary and fixed types. As an example, one smelting furnace which our representative recently saw in operation (see Fig. 1) is cylindrical in shape, and is charged with a suitable mixture of ore concentrates and coal (the latter to assist in the reduction of the oxides); and after the first smelting operation has been completed the furnace is rotated on its bearings until the tapping hole and slag hole, which formerly were at the top, are in a position for tapping, as shown. In some instances, however, the further refining is done in a reverberatory furnace with a

specially constructed hearth for grading the metal. The furnace construction is adapted for the system of oil-firing used. This system, it may here be mentioned, does not require the furnace construction usually associated with oil-firing. As will be explained later, the system of firing employed ensures the perfect combustion of the oil without demanding the long hearth usually found necessary. One of these refining furnaces accommodates 50 tons of metal at a heat.

FIG. 2.—OLD TYPE OF COAL-FIRED REVERBERATORY FURNACE.

and it is a common thing to observe clouds of tin oxides hovering round the shaft top. But at the Merton Works what fumes escape from the furnace are passed through a channel constructed throughout the length of the works, before they enter the chimney shaft, and practically all the loss is thus recovered. This is evidenced by the clean state of the shaft top, which shows little if any discolouration by the tin-oxide fumes.

While we do not propose to discuss in detail the

FIG. 3.—CORNER OF REFINING AND MIXING ROOM AT THE TANDEM SMELTING SYNDICATE'S WORKS.

It is worthy of note that the system of firing and the construction of the furnaces allows practically no loss of tin through voltalisation. This metal, being very volatile at high temperatures, is generally subject to considerable loss in smelting, unless precautions for condensing and recovering the fumes are employed; smelting operations, mention should be made of a novel furnace for the recovery of tin from the slag discharged by the smelting furnaces. This is strictly a blast furnace, water-cooled, but without the usual blast-furnace stack; and in place of coke firing and air blast, the reduction is accomplished by two Höveler

oil-fuel burners, as in the other smelting and refining operations. Lead is used in the charge to collect the tin from the slag, and the product from the furnace is a tin-lead alloy, which is run into pigs for further use or disposal.

The Höveler Oil-Fuel Burner.

When the works were first established at Merton the question of the fuel to be used came up for consideration. Formerly coal had been employed in the usual type of reverberatory furnace, but various considerations led to the adoption eventually of oil. We understand, however, that the actual cost of fuel consumed does not show any material advantage in favour of oil; the preference is rather on account of its adaptability

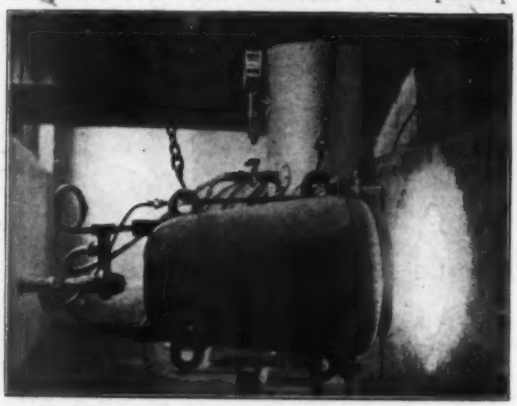


FIG. 4.—HÖVELER BURNER FOR OIL FUEL.

and efficiency. The early experiments did not prove very satisfactory, though a variety of burners were tried; and it was not until the managing director of the Company, Mr. H. F. Höveler, took the matter up personally and designed a suitable burner that any substantial satisfaction was recorded. The burner ultimately evolved is illustrated herewith.

The usual design of so-called oil-fuel burner is, strictly, merely an atomiser and injector or sprayer. The fuel passes through an injector which mixes it with air under pressure, and the result is that the oil is delivered into the furnace in a state of fine division. But the actual ignition of the fuel is not a function of the burner; and consequently the efficiency of the fuel is a variable quantity, according to the design and the temperature condition of the furnace. With the Höveler apparatus, however, the case is different. This consists of two distinct parts; the first, an atomiser or spraying device, delivering the fuel ready for combustion into the second part, a conical combustion chamber. The spraying device is illustrated in Fig. 5. The oil gravitates from a storage tank conveniently placed slightly above the level of the burners (in the case of the Merton Works the 6,000 gallons tank, which supplies all the burners in use, is situated in a field outside the works), and enters the atomiser at the inlet A. In cases where a heavy, viscous oil is employed the fuel supply pipe leading to the inlet A is brought within reach of the heat of the furnace to render the oil more fluid and easier to atomise. Compressed air under a pressure of from 10 lb. to 20 lb. is introduced at B, and this flowing along the passage C produces an ejector action at the mouth of the tube D, through which the fuel flows. A needle valve operated from the milled nut E controls the flow of fuel from the tube D, the tip of which is of nickel, to reduce erosion. The ejector action produced at this orifice, in additional to sucking in the fuel, draws atmospheric air through the holes F in the external casing, the supply to which can be regulated as required. At G a second or main compressed-air inlet is provided. The action of the compressed air on the fuel flowing from the tube D is to deliver it in a very finely atomised stream, and mixed with the correct amount of air to secure its complete combustion. The sprayer is adjustably fixed to the combustion chamber, as shown in Fig. 4. That chamber consists of a conical iron casting lined with fire-brick, the interior diameter being such as to just envelop the conical jet of mixture, leaving a margin of about an inch all round. Contact with the heat of the combustion chamber ignites the mixture, which is emitted as a flame. At the discharge end of the combustion chamber the orifice is contracted, so as to reduce the diameter of the flame. The exact amount of this contraction is of great importance in the working of the apparatus.

It will be seen that only the actual flame enters the furnace, and that the heat being thus independent of the condition of the furnace interior, can be maintained and regulated at will by the manipulation of the sprayer valves. During the Company's early experiments with oil-fuel, trouble was experienced with oxidation of the metals through contact with the air introduced to support combustion. With the Höveler burner, however, this trouble is obviated, since the flame from the combustion chamber fills the orifice through which it enters the furnace, and allows no unconsumed oxygen to enter. The whole apparatus—sprayer and combustion chamber—is suspended by chains (as shown), or fixed in any convenient manner, so that it can instantly be removed, if necessary. The sprayer, also, can at any time be detached for cleaning or examination and replaced with a minimum of labour and inconvenience, and without removing the combustion chamber.

The great point put forward in favour of this apparatus by the Tandem Smelting Syndicate is the ease with which the heat may be controlled, and the ready application of the burner to any purpose, from steam-boiler heating to metallurgical work. So con-

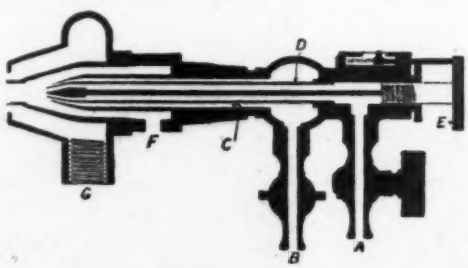


FIG. 5.—ATOMISER OF THE HÖVELER BURNER.

vinced are they of its possibilities that a company has been formed to manufacture and supply the apparatus for various applications. The burners and furnaces, it may be mentioned, are fully protected by letters patent.

At the Merton Abbey Works some of the metal melting pots for melting the refined metal for pouring into ingot form are at present still being heated by coal, but the majority of the operations are conducted with oil fuel, the consumption of this being about 1,000 gallons a day. The starting of the burner is a simple matter. A little oil is allowed to pass from the tube D, and a slight supply of air is turned on. A lighted piece of cotton placed at the nozzle of the sprayer then creates a flame sufficient to heat the combustion chamber. The full supply of air and oil can shortly be

turned on, and the burner is ready for use. The quality of the oil, we are informed, is not of much importance. From creosote to heavy German tar oil may be used, and the appliance can be readily adjusted to burn with equal satisfaction. There is no waste at starting and stopping, and the attendance required is only that necessary for adjusting the heat to the requirements of the smelting or refining process.

Pattern Making and Pattern Equipment.*

By W. S. Giele.

The author's object has been to discover, if possible, such fundamental principles and tendencies of development as will be of general application. The larger problem of economic and efficient equipment sub-divides itself into secondary problems as applying to a particular case. Each of these secondary problems finds its solution developed to the highest degree, if not to the ultimate ideal, in specialised industries, in which it happens to be predominant. Advance must come through the general application of these specialised developments.

With this in mind, a number of speciality foundries have been visited and manufacturers of equipment consulted, the secondary subjects being treated with a view to bringing out, as far as possible, the general application of the special solutions.

If there is one tendency predominating all others, it would seem to be in the growing substitution of mechanical for manual operations, both in the construction and in the use of the pattern equipment, and such tendency, if it is to continue, must take the form of adaptation of the mechanical processes and machines involved to the requirements. This adaptation is best illustrated by recent developments in wood-working machinery, paralleling contemporary developments in machine tools, with such modifications as are required for wood-working processes.

Another example is in the development of simple, economical and rapid methods of mounting patterns for use on moulding machines, so that the machine becomes available for the production of castings required in comparatively small numbers, as well as for production of large numbers of castings from expensive and highly developed pattern equipments.

Stoves.

The making of stoves presents several striking and characteristic features as distinguished from other branches of the foundry art. The castings are assembled or "mounted" without having machine work done on them, so that while accuracy of size and shape is not important in the finished structure as a whole, accuracy of fit between parts is absolutely essential. In fact, it would be impossible to build up the stove if the fits between castings did not make such close joints that they could easily be sealed air-tight and also make a good appearance.

The requirements peculiar to this industry have developed methods which do not rely on any abstruse theories nor on scientific accuracy of measurement, but which depend on common sense and care in execution. The basic principle may, perhaps, be said to be the combination of a highly trained eye with the judgment which cannot be embodied in rules, but which comes only from experience.

The writer found at one large stove concern that, given the requirements for a new "piece of goods," the designer or, perhaps more properly, the "architect," first constructed a mental image of what was wanted, and then, bearing in mind the types and patterns on hand, gave it tangible form, sometimes in a clay model and sometimes as a sketch drawn in perspective and shaded, a picture rather than a drawing. After this had been thoroughly discussed and made to embody suggestions from all departments (co-operation is a real force in this plant), it was laid down as a full-size drawing, showing all parts, and *not dimensioned*. The drawing then goes to a gang of pattern-makers who make the master patterns, taking their sizes direct from the drawing. For convenience of distribution to the workmen comprising the gang, the separate details may be traced from the general drawing.

As the castings are very thin, the wood patterns are, of course, extremely delicate, and the methods which are familiar to the stoveman are a revelation to many a foundryman in other lines. For instance, curved pieces are occasionally bent to shape with an expenditure of labour and material but a small fraction of that required to build up and work out such a piece. Possibly such patterns would not be very durable under ordinary moulding conditions, but in this case they are follow-boarded and used only in the production of metal working patterns.

Another feature interesting to the stranger is the production of such irregular shapes as a stove foot, for instance. This compound curved surface, with not a point to measure from, would defy the ingenuity of many a mathematician, but many of those present have seen the wood-carver in a stove pattern shop produce such a piece with apparent ease, working out the exterior surface first, then drawing in the scrolls or other design, curved lines on curved surfaces, and carving them out. And he depends on the eye and on the hand for symmetry.

Few foundrymen have not had difficulties with castings of uneven thickness, and the importance of this is nowhere more vital than in castings which average less than $\frac{1}{8}$ in. in thickness. Here, again, the stove foundryman relies on positive common-sense methods rather than on refined measurements. Thus, the leg above referred to, after the outside has been shaped and carved, is cut away at the back, following every irregularity of the design and keeping the metal thickness constant by gauging at every point by means of the well-known tool sometimes called "scissors calipers." Even in the case of a gas-stove burner, the half-pattern is shaped inside and out to a constant thickness of metal. Working patterns made from the outside and working core boxes made from the inside of such a master, by moulding

* Paper read before the American Foundrymen's Association, Pittsburg Convention, May, 1911.

processes, will insure castings of uniform thickness.

On this general class of patterns follow-boards are not only required to form the parting in the mould, but are essential to support the pattern against springing during ramming. It is often convenient to carry the construction of the follow-board along with the construction of the pattern, using it as a support for the pattern when working on the exposed side.

In stoves, as well as in other work, where one design runs through a line of sizes, great economies can be effected by standardisation of elements, any one of which may be used in a number of different sizes, and even in the standardisation of pattern elements. Standardisation of core prints is too obvious to deserve mention, but other elements can be treated in a similar manner. For instance, the writer saw a master pattern for an oven door with expensive carved flanges and corners made with two lines of division at right angles to each other, so that it could be extended in both length and width. This one master was used to make a number of working patterns of different sizes and uniform design. The advantage of the follow-board support in the case of this divided pattern is self-evident.

Readers need not be reminded that shrinkage allowances are adjusted to the number of steps and kinds of materials intervening between the original pattern and the finished casting. Thus, in the case of the oven door cited, a master pattern is cast each time the original wood pattern is changed and the working patterns cast from these. The original masters are not always made in wood. They are sometimes made in very soft metal which can be shaped by hand, and melted down so that the material can be used again after the secondary master pattern has been cast. Once the master patterns are completed, they are assembled into a model stove, the simplest, surest and quickest method of checking all dimensions.

The working patterns are probably most frequently of iron, though also made of aluminium, white alloys and brass, the choice of material being governed by exactly the same considerations that would apply in any foundry. The foreman of the pattern shop is properly held responsible for the quality of the patterns, and, therefore, properly the one to judge on the quality of the castings for working patterns. The castings are sand-blasted and then picked to remove the scale, after which they may receive a preliminary polishing on a wire-wheel brush for irregular surfaces, and an emery wheel for flat or convex surfaces, The main work, however, is done by hand with file, scraper and emery cloth, and no man who has ever tried to mould a pattern in sand will deny that too much care cannot be given to finish and particularly to draft.

The working patterns, like the master patterns, are checked by being mounted as the castings are to be, rather than by measurement, and in this final fitting judgment and experience count for more than theory in deciding just how much allowance should be made for the casting operation. Thus, the cope side will not be rapped and the drag side will; more allowance must be made in shoulders on the drag side than on the cope sides. The final test is a simple set of castings made from the patterns and assembled into a stove.

This is a very general view of the method of developing an equipment of patterns for making stoves, as practised in the manufacture of heating and cooking stoves, gas stoves, steam and hot-water boilers. The patterns for small parts particularly, and for some of the large parts as well, are mounted on plates or fitted with stripping plates for use on the moulding machine, as will be treated elsewhere in this Paper. Gating on these thin castings is important, as the gates must be of ample area to flow the metal over the whole of the mould without the formation of cold shuts, and yet thin enough to break off without breaking into the casting. The use of set gates or gates permanently attached to the patterns is preferred to gates cut by the moulder, which are never twice alike.

In the pattern-shop of the Abram Cox Stove Company, of Philadelphia, all the benches have their left ends towards the windows, thus economising space, giving each man the best possible light and easiest access to machines, and lessening the temptation to conversation between the workmen, because each looks toward his neighbour's back. The superintendent's office is separated from the shop by a glass partition, and is at the end of the line of benches where he can see all the men. The machinery is placed in a line paralleling the line of benches and near the centre of the shop. The usual wood-working tools are provided. One which ought to be more usual in other shops than it is, is a first-class grinding machine for sharpening tools, carrying a revolving oil stone and a cone-shaped stone for gouges. Another, in the same class, is a small jointer taking such pieces as are usually planed by hand. The knives of such a machine are much more easily kept in perfect shape than on a larger machine, and it is a time-saver on work within its range. Another time-saver is a rack containing in marked compartments, perfectly seasoned and accurately planed stock.

The varnishing in this plant is confined to a room provided for the purpose. The metal workers are provided with convenient motor-driven grinding stands carrying emery wheels and wire brushes that save much hand work. There is also a small portable electrical drill which can be attached to any lamp socket and taken to the work at the bench or vice. The soldering forges are gas-fired in this shop, and arranged with a pilot light and automatic valve, the latter being operated by the weight of the soldering copper when it is laid into the forge. The metal workers are provided with a small moulding department in which the alloy patterns and pattern plates are cast, and in which the actual working of a pattern in the sand can be conveniently tested. This department has in it the furnaces for melting the pig metals from which the alloys are made.

The lessons to be drawn from the general methods outlined as applicable to other branches of the art might be summarised as follows:—

(1) Starting with a definite notion of size, and saving the time consumed in laying out a piece to scale and then laying it out again full size in the shop.

(2) Saving in time required to dimension the drawing, and the complication of drawing by dimension lines and figures.

(3) Elimination of mistakes in putting down and reading dimensions.

(4) Saving filing and reference systems; each piece being given a number, and the master or secondary master pattern giving an absolutely sure record of the piece. This method makes it possible to furnish repairs for stoves made fifty years ago.

(5) Absolute checking of dimensions without possibility of errors in measuring, by assembling patterns.

(6) Concrete idea of appearance of finished product before it is made, through assembled patterns.

(To be continued.)

We have received from Messrs. Alldays & Onions' Pneumatic Engineering Company, Limited, Birmingham, their new list of smiths' hearths of a variety of patterns. The pamphlet also gives some useful information on the lay-out and equipment of smithies.

Brass Foundry Practice.

Address before Birmingham Foundrymen.

The Birmingham Branch of the British Foundrymen's Association commenced its Autumn Session on Saturday, October 28th, when about sixty members met at the Technical School, Suffolk Street, to receive the Presidential Address of Mr. H. L. Reason. In his opening remarks MR. REASON said:

It is proposed on the present occasion to depart from the usual practice of giving a summary of the year's work in the various branches of founding and research, and confine this address to brass-foundry practice. We have had some splendid Papers on almost every branch of iron-founding, but up to the present very little has been heard of what brass-founders are doing. I will, therefore, endeavour to give a broad outline of brass-foundry work.

First to be taken into consideration when commencing to design a brass foundry are the Foundry and Workshop Regulations which came into force on January 1, 1910. Unless the building contains 2,500 cubic feet of air for each person, with ample ventilation, it is necessary to provide mechanical means for removing from the shop the fumes given off during pouring. It is also compulsory to provide washing accommodation.

As an example of the apparatus which might be used for the removal of fumes, the speaker showed on the screen a specimen of Lyne's fume extractor, by means of which a cover is fixed to the metal pot, and the fumes are carried away through a tube. It was explained that 200 of such appliances were in use in Birmingham. The speaker said that although it might appear cumbersome, the men could use it without inconvenience. The suction was by the main tube being connected to the stack, and to prevent it spoiling the draft in the stack, dampers were fixed near each tube connection, which were kept closed, except when the crucible was drawn for pouring. The tube was made with a coil of wire covered with asbestos cloth which could be easily repaired.

A view was next shown of an arrangement for removing fumes during operations, at the works of Messrs. Gresham and Cravens, Salford (see Fig. 1). It consisted of a pair of swinging arms fixed in the roof, working on a swivel joint, which enabled the receiver to be placed at the point where the fumes were emitted. A fan was fixed for the purpose of driving the fumes into the atmosphere.

Another illustration showed a modern brass foundry having an area of 110 ft. long by 66 ft. wide, with a height of 20 ft. to the centre of the span, and twelve furnaces capable of dealing with seven tons of metal per day of ten hours. In this case, the furnaces were situated at the far end of the shop, and to get rid of the fumes four ducts had been put into the floor, which discharged through gratings into the shop. A fan was fixed into the roof for driving the fumes into the outer air. The speaker said he understood this system worked very satisfactorily. With regard to the shopping arrangement, the core-making shops were at the rear, the girls working on the left, and the men on the right.

The speaker proceeded to describe and illustrate a variety of furnaces, commencing with the Catalan forge, one of the earliest methods of melting. The reverberatory or air furnace, it was explained, was generally used where large quantities of metal were required, and coal was the best fuel. The speaker continued: "When melting alloys great care must be taken not to get a clear, bright, cutting flame, as this means excess of oxygen which will set up excessive oxidation; and to obtain the requirements doors are fitted in the ashpit to regulate the current of air. The coal consumption in 2-ton to 20-ton furnaces is about ¾ cwt. per cwt. of metal melted. In smaller furnaces from ¾ to 2 cwt. capacity, which can be worked continuously, the coal consumption will be considerably reduced, as the heat from previous charges will be utilised. In the case of the large furnaces there are intervals of days, sometimes weeks, according to the work in hand, when the furnaces are not used."

In exhibiting a view of the brick-built furnace in common use and in which the melting pot is let down into the burning fuel, the speaker remarked that the grating should be 5 ft. 9 in. to 6 ft. from the bottom level, so as to enable a man to walk underneath and give free access for clearing the fire bars and removing the ashes. The damper was employed to regulate the speed of melting, and was very useful in jobbing foundries where metal was required at irregular intervals.

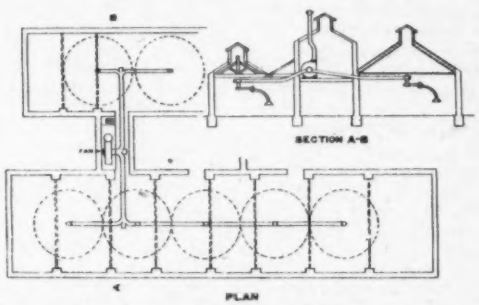


FIG. 1.—FUME EXTRACTING ARRANGEMENTS FOR BRASS FOUNDING.

If this type of furnace were properly designed there would be nothing to equal it for all-round work and economy, and it would probably be found in general favour for many years to come. For the purpose of illustrating the furnace, the speaker showed the view of a workshop having a brick furnace built against the wall, the top of this furnace being 24 in. above the ground. He remarked that after carefully considering the question of what the height of furnaces should be, it had been found that for crucibles up to 100 lbs. the furnace tops required to be about 10 in. above the floor level. This elevation was a distinct help to the man when drawing the crucible. Being able to have one leg against the furnace enabled the operator to steady himself, and apply his strength more effectually when lifting out the crucible. For crucibles exceeding 100 lbs. the furnace should be level with the floor, as in this case the crucibles were taken out with pulley blocks. The question of whether lift-out crucible furnaces should be round or square, had given rise to a good deal of discussion. Personally, he favoured the square furnace, mainly because it was more economical in melting, not requiring so much coke as the round furnace. He quoted as an example the case of a square furnace suitable for a 100-lbs. crucible. It would

require 1½ in. coke space at the sides. The body of coke in the corners would do the melting, and give room for getting tongs on to the crucible, but it would be necessary to have the 3-in. coke space in the round furnace. This, however, made the cubic capacity of the fire space in the round furnace 653 cubic in. larger, and it must follow that a larger quantity of coke would be used. It was advisable when building furnaces to make them a trifle on the small side, to allow for the burning away and increasing in size.

Exhibiting next a view of Carr's furnace, the speaker called attention to its resemblance to the brick-built furnace, pointing out that its chief advantage over the ordinary furnace arose from the fact that it was self-contained and easy to fix. The coke space in the various sized furnaces for economical melting had been carefully worked out by the patentee. It was a great advantage to arrange the fire bars so that they could be easily removed from the bottom of the furnace. Mr. Reason spoke approvingly of a class of furnace in which there was a space between the bottom of the lining and the top of the firebars. This was valuable as giving additional opening for free access of air, and so improving the working by securing the regular burning of coke. As the furnace did not depend upon the air passing through the fire bars, it would work so long as the four side openings were kept clear, and also give the necessary space for the lifting and removal of the firebars.

Coming next to the Caisson furnace the President showed a view of a furnace fitted with drop bottom and sliding top, and proceeded to relate an experience:—"Some years ago I fixed six of these furnaces to replace brick ones which were worn out. The idea was to secure an improvement on the brick furnace, but it was found that they were anything but an improvement. The chief trouble was the great radiation of heat through the sides, which in summer made the shop very hot for the workmen. In the brick-built furnace much of this radiated heat was retained and utilised for the melting. The coke consumption for natural-draft coke-fired lift-out crucible furnaces would be 20 to 25 lbs. of hard coke per 100 lbs. metal melted. If gas coke were used it would require 25 to 50 per cent. more. In small crucibles of 60 lbs. and under the difference is not so marked. The average temperature for brass melting is about 1,600 C., but it was found that a number of furnaces were working at 1,250 C. When melting manganese-bronze and German silver it is necessary to have the furnace 1,650 Centigrade. The average loss in melting is about 5 per cent."

A series of views next exhibited various features of the M.R.V. forced-draught tilting furnace, and the Morgan stationary tilting furnace, which latter was particularly suitable for mixing alloys and running down scrap into ingots. Various other types of the Morgan tilting furnace were also illustrated.

Speaking generally of forced-draft tilting furnaces the speaker said: "Comparing them with good pit furnaces it is found that the chief advantages are a saving in coke of from 10 to 15 per cent. Saving in crucibles amounts to about 25 per cent. due to the avoidance of wear and tear on the crucible in lifting in and out of the furnace. The speed of melting is increased, and the life of a crucible when melting brass by these furnaces averages 46 heats. More metal can be melted by one man per day, inasmuch as the labour of lifting crucibles in and out of the furnace is abolished. The blast pressure is very low, only 1½ to 2 inches water-gauge being required. This type of furnace is suitable for foundries as it does any work, mixing alloys or running down scrap into ingots."

The speaker next proceeded to describe and illustrate a variety of oil-fuel furnaces. Taking first the Charlier rolling furnace, used for melting aluminium, brass, gunmetal, etc., he said that in one large brass foundry in the Midlands there were two furnaces melting on an average three to four tons of gunmetal per day. The furnace was also extensively used in aluminium foundries. With regard to speed, it was possible to melt brass in a No. 2 furnace at a rate of 600 lbs. in forty to fifty minutes. For aluminium, fifteen minutes would be required to melt 300 lbs. These furnaces, it was explained, were not recommended for alloys high in zinc, as the large amount of air blown in sets up excessive oxidation. The Morgan tilting furnace of type "S" was shown as an example of an oil-fired tilting furnace, which was arranged to swing clear of the burner when tilted.

Describing the Sarco oil furnace, of Continental make, Mr. Reason remarked that none of these furnaces were working in this country. The chief features were that the melting and combustion chambers were separate, and (according to the makers' figures) the oil consumption and blast pressure were very low. A special-shaped crucible was employed, and, generally speaking, a crucible would stand 50 melts. When starting up, the crucible was brought in twenty minutes to a white heat before receiving the metal. In the event of a crucible burning through, the metal would collect at the bottom of the furnace and could be recovered at practically very little cost. Next described was the Allday oil burner, fitted with controlling gear which, it was explained, had been fitted to the Charlier furnace with great success. The oil was controlled by a valve spindle, and the amount of air was regulated by the screwing of a cap. The oil and air, meeting just before leaving the nozzle, sets up a violent action, which thoroughly atomises the oil, reducing it to a fine spray. There was no flame at the nozzle, and combustion would take place inside the furnace, where a temperature of 3,000 degrees F. could be obtained. On this the speaker remarked, "The low blast pressure required is one of the best points of this burner, ten inches water-gauge, or about one-third of a pound per square inch, being sufficient for melting brass or gunmetal, as against 25 lbs. upwards by other pattern burners. The oil consumption is about two gallons of coal-tar oils per 100 lbs. of metal melted." The speaker pointed out that when metal has to be taken from tilting furnaces in ladles, it is necessary to have a convenient arrangement to heat them, so as to avoid chilling the metal. Of this heater a specimen was exhibited.

Coming next to the Allday high-pressure gas crucible furnace, the speaker said that rapid strides had been made of late with high-pressure gas for melting metals. "I visited the Birmingham Corporation's foundry at Windsor Street a few weeks ago, and saw a trial run on strip metal casting of which the composition was copper 72 per cent. and zinc 28 per cent. The furnace was quite cold when started, not having been used for some days. A run of five 160 lbs. melts was made. The cost came out, with gas at 1s. 6d. per thousand ft., at 7.54d. per cwt. for the day's run. After the first melt the cost was reduced to 6.4d. per cwt. The speed of melting averaged one hour and ten minutes for 160 lbs. The average loss in coke furnaces for this class of work is about 2 lbs. per cwt.; but in this case it came out at 1.4 lbs. per cwt. There is no flame at the burners or at the top when the cover is removed, it being incandescent in the furnace.

Coming next to the Wright high-pressure gas furnace, two examples were exhibited, one round and another square. Of the latter type it was explained the Birmingham Aluminium Castings Company, Limited, have four working on aluminium. "The manager states the cost of labour as compared with coke furnaces has been halved. There is an increase in the metal melted per pot, with less oxidation, owing to a reducing atmosphere throughout the furnace; the method is much cleaner, as there is no stoking up and carting away of ashes, while, as the heat is under perfect control, a

more even alloy is secured. In brass foundries we experience more trouble from the treatment of the metal in the furnace than we are aware of. One of the chief advantages of a gas furnace is that the operator has complete control of the temperature in the furnace. On this account, and the prevention of oxidation while the metal is in the pot, the loss of metal is reduced in many cases as much as 25 per cent." It was explained that the burners were set tangentially, so that the flame played between the centre pedestal and the outer walls of the furnace, and in this way cutting away and damage to crucible was avoided, as the heat above the pedestal was regular and uniform.

Explaining the use of the high-pressure gas blow-pipe for mould drying, the speaker said the abandonment of the cumbersome air-pipe strongly appealed to them. By a handle the gas was regulated and made to pass round the outside of the centre jet, which was thus made to become low-pressure, owing to the large opening. After lighting, the gas was admitted by a small tap to the small centre jet, and as the gas was high-pressure, the effect was like that of air-blast, but giving a flame 10 per cent. hotter for the same gas consumption from the usual type of air-blast blow-pipe.

The value of pyrometers was next strongly emphasised, the speaker remarking that pyrometers were slowly but surely becoming a necessary part of the equipment of an up-to-date brass foundry. They were regularly used in aluminium foundries, with very beneficial results, while brass foundries were beginning to make use of them. An illustration showed the method of operating the thermo couple. The temperature was taken by placing the stick in the crucible or furnace, as the case might be. The stick could be burned away

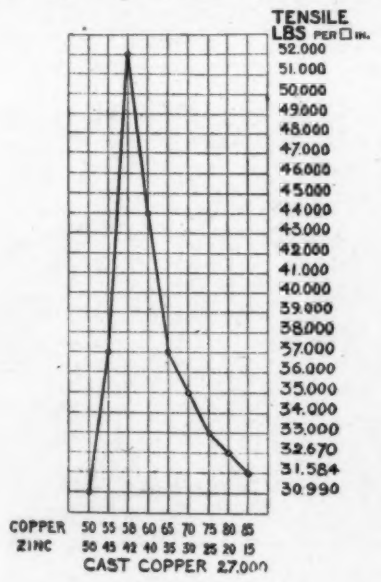


FIG. 2.—DIAGRAM SHOWING EFFECT OF ZINC ON COPPER.

until too short for use, without interfering with its recording of the temperature. By coupling several stations to a switchboard, the temperature of any one station could be taken by switching on to the required number.

The Constitutionof Alloys.

The remainder of the address was devoted to the physical constitution of alloys. Dealing with gunmetal, the speaker said that the alloy, copper 88 per cent., tin 10 per cent., and zinc 2 per cent., was still the best metal for all-round general work. It gave a tensile test of about 13 tons per square inch. It was impossible to tell a good gunmetal by the outside appearance.

Dealing with the bearing of the mixtures on the strength of the metal, the speaker pointed out that in regard to copper-zinc alloys the highest tensile strength was obtained with just over 40 per cent. zinc. Beyond that point the tensile strength and elongation fell rapidly until 50 per cent. was reached. At that point it became a hard, brittle alloy, of no commercial value. Ordinary brass was composed generally of about 60 per cent. copper and 40 per cent. zinc. This mixture had a good yellow colour, and with it it was possible to obtain 25 tons tensile strength and 50 per cent. elongation. Red brass contained 90 copper and 10 per cent. zinc.; this metal could only be used for ornamental work, not being strong enough to stand much shock or strain. The effect of zinc on copper was shown by the table (Fig. 2) of tensile tests.

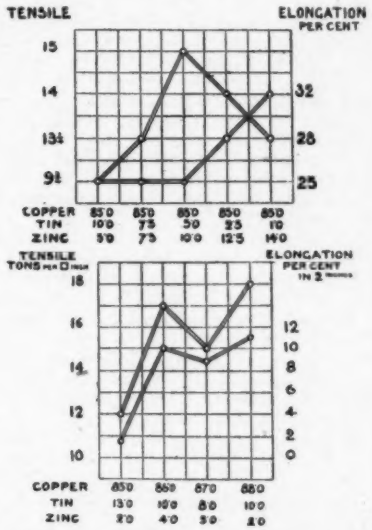


FIG. 3.—DIAGRAMS BY REASON, (B) LONGMUIR, ON GUNMETALS.

Regarding diagram A (Fig. 3) on the gunmetals, Mr. Reason brought out some interesting points. "The percentage of copper (85) is the same throughout. Below 85 per cent. the colour is too yellow to be termed gunmetal. Beginning with 10 per cent. tin, with a tensile of 9¾ tons, by taking the tin away and adding zinc the tensile strength is raised until 10 per cent. zinc is reached. Beyond this point the tensile falls, but does not go below 13¼ tons. The elongation remains stationary until 10 per cent. is reached and then rises to 32 per cent. This chart shows that zinc raises the tensile strength to a greater extent than the same percentage of tin in these alloys." A further diagram showed a series of Longmuir's tests. These, remarked the speaker, confirmed his own tests, as again the addition of zinc increased the tensile strength.

A diagram by Thurston showed that the highest tensile strength was attained with about 83 per cent. copper and 17 per cent. tin, but this was a hard, brittle alloy with no elongation. The elongation line was very important in that series. There was a sharp drop before 10 per cent. tin was reached. If the metal

was not sufficiently hard at this point it was better to add phosphorus as a hardening agent instead of increasing the tin, although in the case of bearings 13 per cent. of tin was sometimes used.

The last metal dealt with by the speaker was phosphor-bronze, which Mr. Reason described as the most important metal in the brass foundry. "For hard wear and tear, such as we have in motor-car work, I think this metal takes first place. The addition of phosphorus to copper-tin alloys up to 0.5 has a beneficial effect. It removes any oxygen present, thereby raising the tensile strength and elongation. A good phosphor-bronze for general work would be, copper 90 per cent., tin 9.6 per cent., phosphorus 0.4 per cent. This would give 18 to 20 tons tensile, with about 15 per cent. elongation on six inches. If a harder metal is required, take copper 88 per cent., tin 11 per cent., phosphorus 1 per cent. In cases where a very hard metal is required, 1½ per cent. phosphorus may be added. Beyond 2 per cent. phosphorus the metal is too hard and brittle to be of any use. Phosphorus is added in the form of phosphor-copper or phosphor-tin, just before the metal is taken from the furnace.

"The inclusion of lead in any of the alloys has been purposely avoided, as it brings down both tensile and elongation. It is only used to make the metal machine easier, but for this purpose it should be kept within 3 per cent. If the metal contains more than this quantity, either in brass or gunmetal, trouble may be expected, more especially in steam and hydraulic work, owing to segregation, but these remarks do not apply to high lead alloys for bearings. All the tests given were of sandcasts, and what might be expected under ordinary conditions."

Dealing with fluxes, the speaker said these were unnecessary if the metal were good and carefully melted. Where scrap metals were used to a large extent, or in cases where continued or bad melting had caused a deterioration in the metal, a small percentage of phosphorus, varying from 0.05 to 0.25 might be used. This would clear the metal of foreign matter and oxides, as well as make the metal more fluid. Other fluxes, including chloride of manganese and washing soda, stirred into the metal at the rate of one or two ounces per 100 lbs. were good deoxidisers. If the alloy contained zinc, their use was not so necessary.

Discussion.

Professor Turner said the President had given excellent reasons for retaining the old, square furnace, provided that the size was correct. Another point raised related to the addition of a suitable portion of zinc, which gave a stronger alloy than if tin had been used alone. When they remembered that zinc was £25 a ton, and tin £175, they would realise its importance, especially if a better product was obtained by the use of zinc. There was the further advantage that the same difficulty in the way of fluxing to get a fluid material was not experienced with zinc; the tin oxide entered more into combination with molten metal, and so gave more trouble in re-melting.

Mr. Walters, who it was explained was present on behalf of the Corporation High-Pressure Gas Department, and who was the patentee of one of the burners used by the Company, said that in Birmingham high-pressure gas was being increasingly employed for melting brass, gunmetal, copper-tin alloys and copper-zinc alloys, and the department had lately laid down high-pressure mains throughout the principal thoroughfares and the commercial districts of the town for supplying high-pressure gas. That gas might be used for annealing in practically any type of furnace. There was a great advantage in the use of such gas where zinc was employed because in a coke furnace the distillation of the zinc caused a great deal of it to pass off as zinc fumes, and this made it impossible to secure great accuracy. But with a gas-fired furnace and the securing of a reducing atmosphere the loss could be reduced to a minimum. In a coke-fired furnace the loss was 2 per cent., as compared with 1.4 per cent. with gas, which meant a considerable saving, and the true value of any loss could only be ascertained if they reckoned that loss plus the labour expended in the metal. The speaker gave a considerable number of details showing the great economy of time and material secured by gas firing.

A hearty vote of thanks was proposed by Mr. A. H. Hoirns, who remarked that he was very glad to hear of the economies effected with high-pressure gas, and he could not help feeling that in the not distant future the coal- and coke-fired furnace would disappear; but he thought that the future furnace would be some kind of electric furnace.

Mr. R. Buchanan seconded the resolution, which was carried heartily.

Process for Blast-Chilling of Cast Rolls.

The difficulties experienced in casting rolls for sheet and tinplate mills, due largely to the difference in the respective rates of cooling of the roll body and the neck, are well appreciated in the foundry trade, and considerable interest attaches to any apparatus or method which promises to overcome the internal strains and weaknesses set up. We illustrate herewith, from descriptions recently published,* a method of producing blast-chilled rolls now being operated by The National Roll & Foundry Company, Avonmore, Pa., U.S.A., who are manufacturing sheet and tinplate rolls under patents granted to Mr. J. B. Baird. This process is one of the most recent departures from the old way of making chilled rolls, and it is

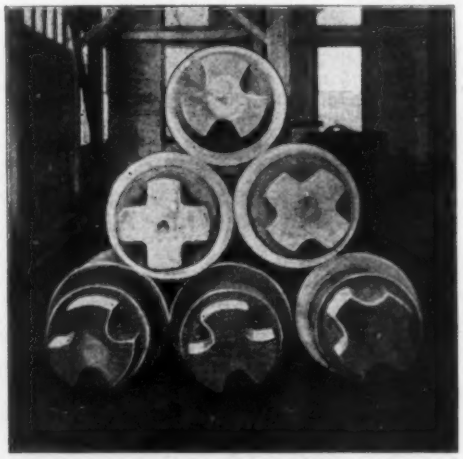


Fig. 1.—Group of Rolls, showing Uniformity of Chill on Sinking-head Ends.

claimed that not only is a perfectly even chill produced, but a surface is given to a sheet or tinplate roll which is practically the same as that given by the water chilling process and without the risk of internal stresses in the metal. Fig. 1 shows a group of sheet and tinplate rolls made in this way, while views of the mould assembled for casting a blast-chilled roll and partly dismantled are given in Figs. 2 and 3 respectively. In Fig. 4 the positions of the various

* "Iron Age" and "Iron Trade Review."

parts before being attached to the mould are illustrated.

The process employs an ordinary air-blast that quickly cools the roll and at the same time does not instantly cool the charcoal-iron mixture. The time of cooling is absolutely within the power of the operator, so that the metal can be set rapidly to get the necessary polish for the face and then have the body cooled gradually to eliminate the casting stresses. Other advantages claimed for this process are simplicity, practicability, an even depth of chill and the absence of wave marks on the finished sheets.

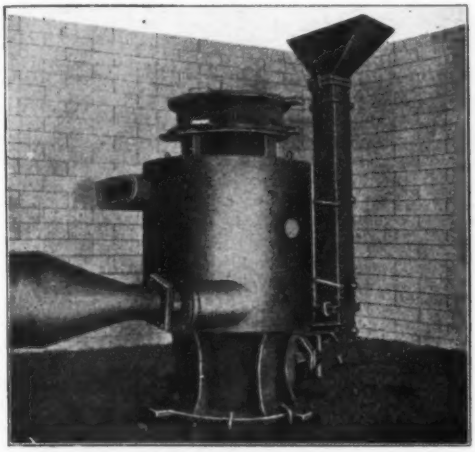


FIG. 2.—MOULD ASSEMBLED FOR CASTING BLAST-CHILLED ROLLS.

In making rolls by the air-blast process a mould is used which has the blast pipe connected to the chilling section of the mould, as shown in Fig. 2. This pipe is connected at the outer end to a large blower capable of furnishing the blast for several moulds at a pressure sufficiently high to enable the

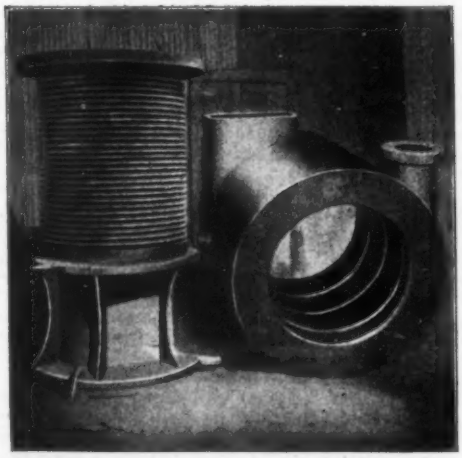


FIG. 3.—CHILL AND OUTER CASING OF MOULD FOR CASTING BLAST-CHILLED ROLLS.

operator to control the cooling effect at will by manipulating the gate valve where the blast enters the mould. A thermometer is placed in the rectangular opening near the top of the chill proper to indicate the temperature of the blast at the point of egress from the mould. This temperature, in conjunction with the air pressure being used for the blast, gives an indication of the speed of the cooling operation.

The chilling section of the mould, which is designed to enable the heat from the body of the roll casting contained in it to be radiated quickly, is shown in Fig. 3. This arrangement produces and retains an even depth of chill, and prevents re-annealing of the chilled roll face, but does not, it is claimed, interfere with the elimination of casting strains in the body of the roll proper. The outer casing shows the circular inlet for the blast connection and the spiral grooves in the interior, through which the air must pass before reaching the rectangular opening through which the heated air escapes to the atmosphere.

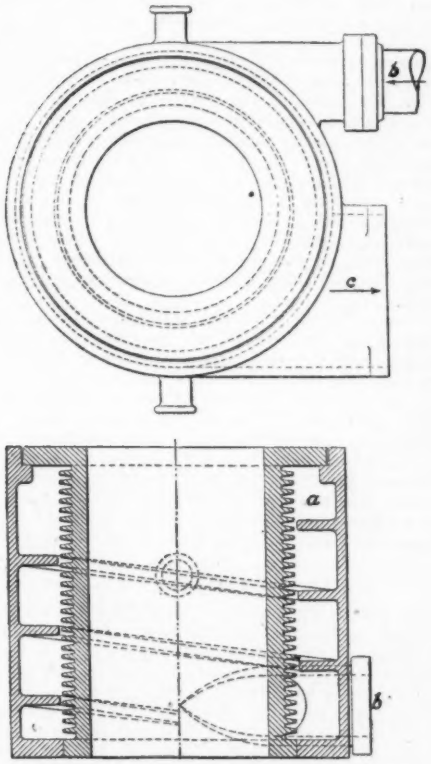


FIG. 4.—PLAN AND SECTION OF THE FLASK.

Referring to Fig. 4, which shows the position of the various parts before attachment to the mould, there is an air space, *a*, existing between the outer and inner walls through which the blast under pressure is forced continually from the blower. The temperature of the iron mould is controlled at will, as the blast is increased or decreased, thus regulating the volume of air that passes through the mould. This is secured by connecting the 10-in. blast pipe to one end of the iron mould *b*, and exhausting the heat-laden air into the atmosphere at the other end of the mould *c*, the thermometer being placed in the exhaust to show the heat that is absorbed from the mould by the air blast. In this way the temperature of the chilling mould may be easily varied by the operator by varying the amount of blast used. The even depth of chill which is thus produced is shown in Fig. 1.

Practical Hints on Moulding and Casting Aluminium.

The comparatively low price, bulk for bulk, of aluminium, as compared with the copper alloys, is directing the serious attention of engineers and other users to the lighter metal. The high tensile strength of the aluminium alloys renders them useful for a great variety of purposes. They have found considerable employment in the motor-car industry, and are used for crank-cases, gear-boxes, carburettors, radiators and a number of other parts and details. General engineers are also becoming more partial to aluminium castings for many purposes, on account of their lightness, quite apart from the cost; in fact, alloys of aluminium are largely employed at the present time in various branches of engineering work. Brass-founders, therefore, frequently find themselves called upon to handle the metal on a more or less extensive scale. By those who have studied the question it is acknowledged that aluminium castings are best produced in a foundry devoted entirely to that metal and its alloys; for the slightly different procedure in moulding and melting, due to the nature of the metal, when compared with brass-founding, is often a stumbling-block to the founder who does not properly realise these differences. But since there are many brass-founders who could with advantage undertake aluminium work, a few hints on the matter may prove useful.

If normal precautions are taken, suitable aluminium alloys should not be difficult to cast. The melting point (about 650 deg. C.) is far below that of iron and even that of the brasses, and the same trouble should, therefore, not occur in regard to gases in the mould and the scabbing of the mould. With a sand fairly free from gas-producing substances and of the right texture, there should be a comparatively small amount of gas generated when pouring; and since the heat of the metal in the mould is little more than half what a mould for cast-iron will stand, it is fairly obvious that scabbing would indicate bad moulding.

Moulding.

The principles governing moulding for aluminium castings, while broadly the same as for brass, are different in certain respects. Some founders consider that the sand for aluminium moulds should be rather finer than for brass moulds, though not too close in texture, as that would give trouble with the escape of gases. In opposition to the claim that has sometimes been made that the facing sand, particularly, should be very finely sieved, practical experience shows that very fine sifting does not give the best results. The procedure for ordinary green-sand work is nearer the requirements for aluminium, and the sand used for the former is generally fine enough for the latter. In fact, green-sand moulding, with some differences as regards ramming, etc., is the usual practice for aluminium.

The metal during cooling is subject to considerable shrinkage, and consequently a flexible mould is necessary. For this reason the sand must not be rammed hard, or the result will be strained or cracked castings. This, of course, does not so much apply to simple designs where unrestricted shrinkage is possible, as to more or less intricate castings where a more yielding mould is necessary to accommodate the shrinkage. For the latter, it will be readily seen, the hardness of the dry-sand mould would prove objectionable; while at the same time the dry-sand mould would give little advantage and be more expensive. Certainly a somewhat more skilful moulder is required for green-sand work, for any excess of water may spoil the mould, while the texture of the face also is required to be smooth but open-grained. The lightness of the ramming, too, may necessitate a more extensive use of gaggers to prevent the mould dropping in overhanging portions. The essentials are, the mould must be just sufficiently firm to retain its form and receive the metal—more than that is unnecessary in the way of hardness and stiffness.

Having made the moulds with the desired grade of sand, say a fine floor sand for the facing and the rest of the mould rather coarser in texture, it may be dusted with French chalk or lycopodium powder if a clean surface is desired. Tub or bench moulding in the ordinary brass-foundry flasks is usual for the general run of aluminium castings, though large work may be moulded in the floor as with other metals.

Ease of Coring.

A noteworthy feature is the ease with which aluminium castings may be cored. Owing to the lightness of the metal (the specific gravity being little more than that of the core), chaplets to prevent lifting by the metal pressure are not required. The core has only to be held in place for the pouring, and does not show any tendency to lift when the fluid metal surrounds it. This feature greatly assists in obtaining sound castings of designs that would require a number of chaplets with the heavier metals.

The cores require special attention. They should be well vented to allow the ready escape of any gases generated, and should also allow the full and unrestricted shrinkage of the metal surrounding them. The mixture must give a core with a hard, clean face that will not require a core-wash, as this latter treatment closes the pores too much and is not necessary with a metal having such a low melting point as aluminium. The core, however, should not be of a consistency which will require considerable heat to disintegrate it, for in such case it would remain hard and spoil the casting. It should be just strong enough to stand the pouring of the metal, and no stronger. It is not difficult, amongst the various mixtures and binders now available, to find a material suitable for fulfilling these requirements; in fact, the writer has seen cores for aluminium work which after being baked could be sharply struck against metal without suffering damage but which proved quite successful in use. In most cases, however, such a core would remain too hard under the low heat of the molten aluminium.

Gating.

Gating is another feature requiring careful attention. Unlike some of the other non-ferrous alloys, it is a mistake to make the gates too large. The practice usual with iron serves for most aluminium work, the essentials being to get a steady but not too forceful stream into the mould. This will allow all points to be properly filled; but if the pouring is too rapid there appears to be difficulty with intricate moulds in gettingf the metal well into all parts. A little experience soon teaches the importance of the rate of pouring.

To facilitate the escape of the air and gases from small moulds a vent wire at the point farthest from the gate is sometimes useful, though not generally necessary. With large work, where heavy sections

occur, risers or feeding heads are necessary to take care of the shrinkage. As soon as possible after pouring, the castings should be removed from the mould, so that the final shrinkage may proceed unimpeded by the mould; and in order to do this the risers and gates may be chilled by introducing pieces of scrap metal.

Melting.

One of the most important points to observe in melting the metal is to avoid overheating. The ordinary brass-melting furnace and crucible are quite suitable for melting the aluminium alloys. Some aluminium founders find that the most economical procedure is to employ an iron pan, the top of which completely fills a furnace fired by oil or gas. Such a furnace is said to allow better control over the oxidation of the metal which often proves so troublesome. Where it has been customary to melt some of the high melting brasses, there is danger of raising the metal to too high a temperature. The crucible, charged with pieces as uniform in size as possible, should be placed on a good fire and sufficient coke to last the heat filled round it. Since the heat required to get the metal to the condition for pouring is comparatively little, the fire does not require refuelling during the melt; in fact, the metal can be melted by placing the crucible on a good hot fire without packing it round with fuel.

Having attained a dull-red heat, the metal may be poured, though in the event of overheating, pieces of scrap, gates, etc., may be added to cool it. But excessive oxidation is incurred by overheating, to the detriment of the metal. Common salt may be used as a flux, this being thrown on to the metal as it is removed from the furnace. Chloride of zinc is also useful for the zinc-aluminium, a small piece being added and the metal thoroughly stirred.

If the foregoing precautions are taken, the aluminium alloy are not difficult to cast; but it is necessary to remember that they vary considerably in constitution. It is not proposed at the moment to enter into the question of the mixing of different alloys; it is sufficient to state that regard should be paid to the nature of the constituents, or the practice that gives success with one alloy may prove very unsatisfactory with a different one.

Electric Steel Experiments.*

It is not often that the results of experimental work carried out on the scale of that described by A. Müller in "Stahl und Eisen," July 20, finds its way into print. The work was that carried out by a German steel company on a 3-ton Girod furnace preparatory to equipping their plant with electric furnaces. That connections to such a furnace can play such an important part in the life of the lining and the power consumption of it is well emphasised in the changes made by the author in question on his furnace. Where one connection was made to the top electrode and another to the bottom electrode it was found that the arc was thrown strongly against the opposite side of the furnace to the conductors. The top conductor was then split into two and led to the electrode on opposite sides, a single conductor being used on the bottom electrode. With this system the arc was blown toward the line. The final solution of the problem was to split both the conductors, bring them up to the furnace many feet underneath and then rise vertically, a pair on each side of the furnace, carrying the conductors leading to the top and bottom electrodes just as far as possible side by side. To increase this length the bottom electrodes were in electrical connection with the shell of the furnace so that connection with them could be made high up on the side of the furnace. The splitting of the conductors keeps the arc central and saves half the lining and all trouble with blowing out of the arc. Even the shell of the furnace was finally made of steel of low permeability. The energy saving in the conductor system and shell as revised amounted to 10 per cent. over the first installation. The flat circular arc now carried on the furnace means an even greater saving of electrode, as previously when it was thrown off to one side it caused very uneven consumption and consequent waste of electrode.

The present system of working is to charge the furnace with about three tons of open-hearth metal and put on a current of 4,000 to 6,000 amperes. A highly oxidising slag is formed, and all the phosphorus and some of the sulphur is removed during this oxidising period. The bath is then deoxidised under a new slag formed of lime, sand, ferro-silicon and petroleum coke or scrap electrode ends. This removes sulphur down to 0.01 per cent. On an average five charges are worked in 12 hours, though this is dependent on the amount of impurities to be removed.

With the original form of two conductor connections where the arc was thrown to one side, the silica roof over that side, even with air cooling, lasted only 20 heats. With the four-conductor system the roof now lasts 60 to 70 charges. Experiments are not yet completed as to the economy of using other materials in place of silica for the roof.

The side walls were first formed by ramming a mixture of magnesia and tar around a core shaped like the inverted frustrum of a pyramid. Such a lining cost £36. It was later determined that dolomite would most economically replace the magnesia, so all linings are now made of this material. They last 120 charges and cost £17. The total cost of lining, including repairs to slag line between heats, amounts to 1s. 3d. per ton of steel. The area of the ends of the steel electrodes in the bottom bears the ratio of 0.05 to 80 to that of the whole bottom.

The bottom electrodes are water-cooled in the ends projecting outside of the furnace. The dolomite bottom is rammed in between them with an air tamper, such a bottom lasting 1,000 heats in a furnace run very intermittently. A calorimetric determination of the heat carried out in the cooling water of these bottom electrodes gave 10.1-kw.-hours for the 130-minute run, or about 1.01 per cent. of the total electrical energy supplied, or 2.9-kw.-hours per ton of steel produced. The cooling water used in the top electrode carried out 36.7-kw.-hours, 3.65 per cent. of total energy supplied, or 10.5-kw.-hours per ton of steel. The Paper contains numerous other determinations of the power lost by stoppage, energy requirements for different weights of charges, etc., most of which are given in the form of charts.

The running of this small experimental furnace has thrown much light on the nature of many reactions in the refining of the steel. In the oxidation period carbon is but slowly removed, manganese more rapidly, phosphorus very rapidly, and about 20 to 35 per cent. of the sulphur. The sulphur appears to be removed in three ways: In the oxidation period by the action of the iron oxide in the slags; in the deoxidation period by solution in the high lime slags; and volatilised as silicon sulphide. It has also been noted that oxides, slag emulsions, and gases have a much more important bearing on the physical properties of the finished metal than the sulphur and phosphorus present.

* "Metallurgical and Chemical Engineering."

The Making of a Calender Roller.

By A. Greenhalgh.

The calender roller here described is part of the machinery of a drying frame. These rollers are heated on the inside, either by gas or steam, so that the cloth which is put between them is eventually dried. The rollers are required in various lengths and thickness. To save making a great number of patterns, and also to save time, there is only one pattern used. This is generally a wooden one, about 4 to 5 ft. long, and about 2 ft. in diameter. If a roller of a larger diameter is required, the pattern is battened all the way round.

As these rollers are always cast on end, it will be seen that they can be made to any length or thick-

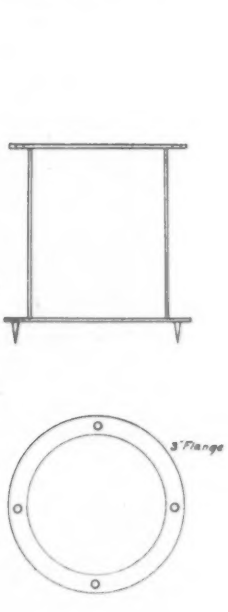


Fig. 1.

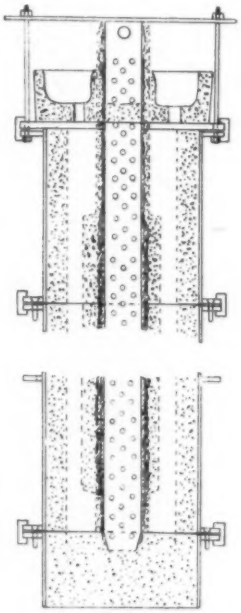


Fig. 3.

ness. They are made in round boxes, in portions about 3 ft. in length. (See Fig. 1.)

The first process is to take the bottom portion, which is more shallow than the other parts; this is filled and rammed up within 2 in. from the top with green sand, then the rest is filled with good, strong facing sand. In some cases, the writer has known iron borings to be mixed with the facing sand, this leaving a very hard surface. When the bottom part has been rammed hard, it is strickled off level with the box edge; upon this joint a hole is made, to allow for the core print to fit in. The pattern is then placed upon this bed end up. Care must be taken to have the pattern perpendicular and square with the bed, for if the pattern is not straight it is most probable that when nearing the top, the pattern will have got close to the box edge. After the pattern has been bedded, parting sand is put on the joint, and then the next part of the box is put on. The pattern is lined with a good thickness of facing sand and rammed up. After having done that the two portions or box parts are cramped together and lowered in the pit for convenience in further working. When the second part has been rammed to the top, the pattern is withdrawn about 18 in., or 2 ft., and another joint is then made. This process is continued with a joint at the top of each box part until the required length of the roller is reached. After this, an extra foot should be added to allow for the scum which will rise to the top. The pattern is then withdrawn, and the whole is lifted out in portions and finished with comparative ease. The finishing required is very little, unless the pattern has been battened, and then, of course, the mould will require to be scraped, after which it is given a good coat of blackwash and put in the stove to dry. The top of the roller is made on a plate which is covered with

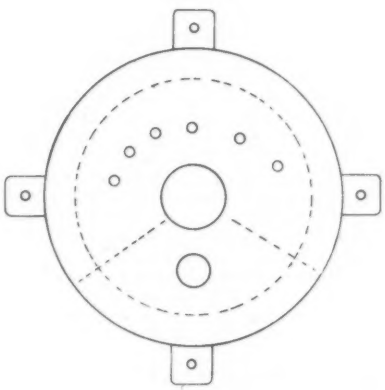


Fig. 2.

loam, dried, and then levellel up. Holes are left in the plate for the runners, riser and core barrel, as in Fig. 2.

After the mould has been dried, the bottom portion is made level at the bottom of the pit. The other portions are then lowered down, but must be supported up about 6 in., so that the core can be steadied in the print better. Before the core is put in, the barrel must be made up at the bottom to prevent the metal entering the barrel. Also, the moulder must get inside the mould and make the joints up with oil and blacking. After the core has been dropped in —which is done by the crane—the top portions of the box are lowered down and cramped together; the whole of the joints are then well stuffed with loam. The core is kept in the centre at the top by long chaplets which fit from the neck of the core to the inside of the box. The plate which forms the top is then put on and cramped to the other portions. The runner and riser are now made on the top of this plate. A special runner box is very often used but is not essential, as any round box which is large enough will answer the purpose; partitions can be

put in to divide the runners from the riser which must be an extra large one, as the roller requires a great amount of feeding.

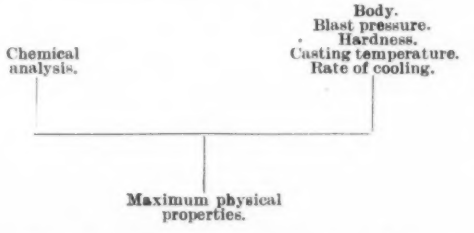
To keep the barrel from lifting, a chain is put over the top and fastened down the side of the box; this answers extremely well. The mould thus closed is ready for casting. Fig. 3 illustrates the closed mould.

The Physical Properties of Cast Iron.

B. F. J. Cook.

On November 11, at the monthly meeting of the London Branch of the British Foundrymen's Association, Mr. F. J. Cook (Past-President of the parent body) delivered an address on "The Physical Properties of Cast Iron," a subject which he dealt with on similar lines in the course of his presidential address at the Newcastle-on-Tyne convention of the Association in 1908 (see "Foundry Trade Journal," September, 1908). The Branch-President, Mr. J. Oswald, M.I.M.E., occupied the chair, supported by Messrs. J. W. Horne (vice-president), T. Whiting, R. Woods, and C. T. Aston (Members of Council).

The lecturer, who illustrated his address by limelight views, dealt with the salient points, other than chemical analysis, that require attention to ensure the maximum physical properties in large and medium-size iron castings, viz., the rate of cooling, casting temperature, hardness, blast pressure, and "body." After referring to the old method of judging pig-iron by fracture alone, and the other extreme of relying solely on chemical analysis, he claimed that the correct method involved an inspection of the fracture (which indicated the structure) plus chemical analysis. The factors to be considered when aiming at the maximum physical properties were expressed diagrammatically as follows:—



The effect of variation in the rate of cooling was illustrated by a photograph of the now well-known wedge-shaped test-piece, which showed at the thick end (6 in. by 6 in.) an open spongy grain, with the grain changing, as the section reduced, to a white iron at the thin end (4 in. by ¼ in.). Such variation could be brought about in the same casting by abnormal differences of thickness of the metal or the nature of the mould and cores. Congested cores, preventing the quick extraction of the heat, would induce the weak structure which characterised the thick section of the wedge shown, by reason of keeping the metal at the critical temperature sufficiently long to allow that weak crystal formation.

The effect produced by the use of chills in a mould, continued the speaker, illustrated the influence exerted by variation in the rate of cooling. Table I was shown, giving tests with chills, each series of bars being cast in the same mould and from the same ladle of metal.

TABLE I.

Class of iron.	Analysis. C.C.	G.C.	Si.	Mn.	S.	P.	Thickness of chill.	Max. stress tons per sq. inch.	Per cent. gain.
Tough	0.234	2.80	1.96	0.50	0.11	1.10	0	11.6	—
							¼ in.	15.15	30.6
							½ ,,	15.6	34.4
							¾ ,,	white iron	
Ordinary engineers' mixture	0.103	3.16	2.52	0.28	0.01	1.30	0	9.8	—
							¼ in.	11.2	14.3
							½ ,,	13.2	35.7
							¾ ,,	15.2	55.1
							1 ,,	16.2	65 3
No. 3 Foundry pig	0.094	3.19	3.366	0.231	0.025	1.522	0	8.1	—
							¼ in.	11.9	46.9
							½ ,,	12.1	51.8
							¾ ,,	15.2	87.6

As regards casting temperature, for all castings where high strength and closeness of fracture were desired, it was necessary to pour the metal at as high a temperature as it could be got from the cupola, without the metal being actually on the boil. After recalling experiments by Mr. Percy Longmuir on the influence of casting temperature, the lecturer quoted two representative results, the first being a white iron suitable for malleable cast-iron work, and the second an ordinary grey iron. Table II gives these results.

TABLE II.

Analysis. C. C.	G.C.	Si.	M.	S.	P.	Casting temperature degrees Cent.	Max. stress, tons per sq. in.	Condition.
3.4	—	0.39	0.05	0.20	0.02	1,321	10.7	As cast
		,,				1,230	15.9	,,
		...				1.120	12.1	,,
								Annealed for 100 hrs. in ore
0.2 to 0.5	3.2					1,320	20.6	
						1,230	29.2	,,
						1.120	26.5	,,
0.52	3.4	1.78	0.28	0.04	0.27	1,400	9.7	As cast
						1,350	14.1	,,
						1,245	10.6	,,

It was explained that the medium temperatures shown, which gave the best results in the experi-

ments, were about that obtained with good hot cupola working.

The lecturer then proceeded to deal with the question of hardness or density, which, he said, bore a marked relationship to the strength of the metal. He also described and illustrated the various apparatus for hardness testing—Brinell's ball or cone test, the rebondimeter, the scleroscope, and the drill test. Cast iron containing a comparatively large quantity of the hardening elements might give much lower hardness test results than an iron containing less of those elements; but this phenomenon was always associated with a more open grain and a coarse fracture (with graphitic carbon in considerably larger flakes) in the iron possessing the larger quantity of the hardening elements.

The question of blast in relation to pressure and temperature was next considered, as having a great effect upon the physical properties of the iron. A diagram from a series of experiments with a No. 3 foundry pig-iron was exhibited to show that the hardness increased directly as the blast pressure increased The tensile and transverse strengths increased with the hardness up to a point and then fell away again.

As regards the quality "body," the lecturer used the term in the sense of expressing "something which is at present not shown by analysis, but which greatly affects the physical condition of the metal." Irons of the same ultimate chemical analysis, he said, gave widely different tensile and transverse test results, but the phenomenon had not been placed on a scientific basis. The explanation lay in the physical condition of the pig-iron used, and the micro-structure of the casting. The highest test results were associated with a peculiar net-like structure of the cementite and the phosphorus-entectic, independent of what the chemical composition of the iron might be, this formation being effected by a particular rate of cooling.

Discussion.

The Chairman, opening the discussion, remarked that since Mr. Cook first published the results of his researches in this matter, the wedge test had become accepted as a standard means of illustrating the effect of cooling temperatures in relation to structure and strength. In a somewhat cruder way this characteristic of varying structure might be examined in any casting that had material variations in thickness, and the effect of the rate of cooling might be readily seen. He did not wish to be hard on the drawing office, for that department often has to meet requirements that could not allow by any means ideal designs from the founder's standpoint; but a close knowledge of the subject of cooling and the relation of the structure to strength would very often enable the designer of a casting to save trouble on the moulding floor. Mr. Cook's lecture was first a call to the foundryman to know more of the phenomena daily taking place under his eyes, so that he might work with more certainty and trust less to luck. But further, it was a demand that the designer, too, should study the structure of metals in relation to design. One of the questions associated with the lecturer's subject was the reliability of the average test bar. It had been proved on many occasions that, owing to the relation between cooling and structure, a test bar might be hopelessly misleading, to the disadvantage of either the founder or the user, according to circumstances. He considered there was room for an entire reconsideration of the test-bar question, so far as certain users were concerned, as many who had little knowledge of the physical properties of cast iron, tied themselves and the founder slavishly to a very doubtful test. The lecturer had opened up far more subjects than it was possible to discuss properly in one, or several, evenings, but members might be able to put forward a number of useful experiences, or seek further enlightenment on specific points.

Mr. Bennett elicited the information that the mixtures mentioned in the experiments were all ordinary commercial mixtures containing 50 per cent. of scrap, with the exception of special experiments with blast pressure. He asked at what point in tapping the best metal was obtained, and what was the effect of remelting—was it desirable from a point of view of quality?

Mr. Nash regarded the Féry pyrometer as unsatisfactory for taking the temperature of a stream of metal; while also it was not suitable for use with, say, a lively Scotch pig-iron in the crucible.

Mr. Barker said he used chills largely in casting, both in the cores on account of thick parts between the cores, and on the outside of the castings. He mentioned the case of a radiator which showed on an internal section a variation from white iron to a close-grained ordinary structure, and asked the cause of same.

Mr. Wilkinson questioned the lecturer as to the effect of traces of the rarer metals, such as vanadium, titanium and chromium. He also drew attention to the fact that experiments by Longmuir and Hatfield respectively on the effect of cooling temperatures did not agree. Further, he desired to know whether a microscope giving a magnification up to 150 diameter was good enough for ordinary work.

Mr. Bartlett asked whether the blast as used for a No. 1 iron would give the same temperature of molten metal if used for melting a No. 6 iron.

Mr. Walker raised the question of the relative efficiency of fan and blower, stating that he was obtaining a softer and closer-grained iron with soft blast from a fan than with high-pressure blast from a positive blower.

Mr. Woof suggested that a difference in the hardness of the ball or cone in the Brinell testing machine, or a difference in the steel of the drill used in the drill test, were these changed, might give a discrepancy in the results. He also claimed that as many troubles in casting were due to coke as to iron.

Mr. Willis desired to know how the lecturer's instruction might be applied in actual practice for the overcoming of foundry difficulties. How could the hardness of certain parts be minimised and the poor structure of other parts be improved?

Mr. J. W. Horne (Branch Vice-President) expressed his strong belief in the combination of chemical analysis and fracture for the grading of pig-iron. It would greatly assist foundry foremen in making iron mixtures to suit the varying requirements of different work. As regards the rate of cooling and its effect on the separation of carbon, an experiment by Sir Lowthian Bell had proved that graphite could be deposited from a hard iron. The experiment in question consisted in casting a block of white iron 6 tons in weight, and breaking it open when cold, when it was found that in the centre a deposit of graphite had formed. He (Mr. Horne) regarded the pyrometer as of little value in ascertaining casting temperatures, since temperature is not an accurate indication of the fluidity of the metal. A fluidity test was better, this consisting of pouring a sample of the metal into a long, narrow mould. A good idea could thus be obtained regarding the fluidity of the metal, and its quality for varying thicknesses. The effect of chills on any section could also be ascertained. Hardness tests, he remarked, did not give any idea of the wearing qualities of the iron—a most important quality in many castings. The drill

test was the most satisfactory of the hardness tests; the scleroscope had no value for cast iron, owing to the crystalline condition of the metal. He asked the lecturer for an explanation of the fact that in certan specimens quoted the combined carbon was less in the chilled than in the unchilled bar. This was contrary to the usual effect, for if chilling were carried to the extreme, giving a white iron, all the carbon would be in the combined form. As to blast pressure, volume was more important than pressure. Systematic experiments with regard to the combined influences of pressure and volume would be very valuable. He further observed that the volume of air blown into a cupola at the end of a melt was bound to be less than at the beginning, owing to the clogging of the tuyeres with slag as the melt proceeded. This might explain certain troubles with cupola work. He also suggested that work be done on the freezing temperatures of common irons.

Mr. Cook, replying to the questions and discussion, stated that the point at which the best metal came from the cupola depended on the working. There was more sulphur in the first metal, since it was longer in melting and hence in contact with the coke. As to re-melting, that depended on the metal. Re-melting a soft iron might improve it up to the point where hardness and tensile strength were both high, as it would increase the sulphur and hardness; but to start with a hard iron meant that it would deteriorate. Hardness tests were, strictly, only comparative tests under the same conditions; the drill test was the best for cast iron. The bars should be always the same size, the best form being 1½-in. diameter cylindrical bars. The blast pressure of 12 oz. was not the best for all work, the blast would differ according to the type of blower, the relative size of the tuyeres, and the area of the cupola melting zone. The larger sizes would take higher pressures; but each founder should experiment with his own cupola to ascertain the best pressure. He considered the Fery pyrometer the best for cupola spout work; as to the accuracy of measurement, all that was required was a comparative test from day to day, and provided the same instrument was used, strict accuracy did not matter. As to the question raised by Mr. Barker regarding the cause of chilled sections in radiator castings, this probably resulted from some metal becoming chilled in pouring and having no chance to recover its heat before it was deposited in its position on the thin section. Its situation would result from the rolling effect of the metal during pouring. Where trouble was experienced with metal not lying quietly against chills, it should be poured as hot as possible with the chills vertical, so that the metal might creep up them. Special elements, such as mentioned by Mr. Wilkinson, if added to the ladle did no good. Aluminium or titanium if so added did not enter the metal, but merely gave a poling effect which cleaned the metal. The difference between the results obtained respectively by Hatfield and Longmuir was accountable to the fact that Hatfield's bars were not of a practical size—they were too thin and thus subject unduly to the temperature of the sand. Regarding microscopes, one for 150 diameters would be plenty good enough for ordinary foundry work. The tendency now was to come down to the lower powers, and Stead's microscope, as supplied by Messrs. Swift & Company, was one of the most applicable, giving a magnification of about 30 diameters. Opinion varied greatly as to the relative values of the fan and the blower. For soft castings the fan was the most suitable, as the high-pressure blower caused a loss of carbon, while the silicon was also oxidised. With a fan the tuyere area should be about one-ninth of the melting zone, and with a positive-pressure blower one-twelfth of the melting zone was enough. If the iron was to be refined somewhat, good results could be got from a blower, with a tuyere area one-sixteenth of the melting zone. He (the speaker) got rid of 0.2 per cent. carbon with good results. As to carbon, the nearer the carbon content was to 3.0 to 3.25, the better the results. Replying to Mr. Woof, the tests quoted were made with the same drills, ground on an automatic machine, and the conditions were the same in each case. As to the remark that more trouble resulted from the coke than from the metal, he would say that bad coke or bad metal would each give bad results; both should be good. The answer to the question put by Mr. Willis was in the use of chills. These could be applied to assist the cooling of parts in order to improve the structure. He agreed with Mr. Horne that the fluidity test was very useful. As to the combined carbon in chilled and unchilled bars, it must not be supposed he meant that lower combined carbon was always found in the former; this would depend on the casting temperature and the rate of cooling.

A hearty vote of thanks to the lecturer terminated the proceedings.

Carbon Influences on Cast Iron.

Before a large attendance of members of the Staffordshire Iron and Steel Institute, at Dudley, on November 18, Mr. E. Adamson (Sheffield and Glasgow) presented a paper on "Carbon Influences on Cast Iron." Mr. I. E. Lester (President) occupied the chair. The paper embodied the contention put forward by Mr. Adamson before the last meeting of the Iron and Steel Institute in London, regarding the condition of the graphite in cast-iron and the influence of silicon on the formation of graphite. The three forms of graphite described were dependent upon the temperature of the smelting and cooling operations, and the influence of silicon under certain conditions was subordinate to temperature. Under "Notes and Comments" of this issue, Mr. Adamson's remarks are more fully considered. The object was to show that the condition of the graphite in the iron was the dominating factor in determining the structure of the metal, and hence largely its physical properties.

The author's claims met with some criticism in the course of an animated discussion. Mr. W. J. Foster maintained that the benefits derived from silicon had in the past been very much misunderstood; its effect in modifying hardness was its most valuable property, the alteration of fracture by silicon being slight, and quite of subordinate importance. Fracture, he considered, was governed by temperature, assuming other conditions were constant. Criticisms dealing with the chemical constituents of cast iron were offered by Messrs. D. Levy, W. H. Coe and G. Hailstone. Mr. R. Buchanan, in a letter, controverted a statement that the casting of pig-iron in chilled moulds led to silicon grading; that might be true of American practice, but in Great Britain silicon grading was in use years before the Americans started casting pig-iron in chills. He would be glad to have proofs that iron run into a chill would retain its hardness, due to such chilling, on being re-melted; there was an idea that American irons were as soft as British, if not softer. Mr. Silvester said that it was absurd to suggest that the importance attached to silicon by the practical ironfounder was merely the result of fashion. Experience had shown that the observation of silicon gave very useful results. In a brief reply, Mr. Adamson said all the results shown in the paper were ascertained by practical experience.

Mr. E. V. Johnson, late technical representative for Willans & Robinson, Limited, in South Wales, has joined the firm of W. V. Waite & Company, Limited, engineers, merchants, and agents, Gordon Chambers, 31, Queen Street, Cardiff.

The Use of Greased Moulds in Brass Casting.

By John Cartland.

At a meeting of the Birmingham Section of the Institute of Metals, held on Tuesday, November 14, Mr. G. A. Boeddicker (President of the Section) occupied the chair, and a Paper was read by Mr. John Cartland, M.Sc., Boyn Research Scholar, Birmingham University, on "The Gases in Cast Brass." The Paper was based upon original research by the author, and was illustrated by lantern slides and blackboard sketches.

It was customary, MR. CARTLAND said, to pour copper alloys through a reducing atmosphere, as without this precaution the metal would have inferior mechanical properties. To produce this reducing atmosphere the metal was usually poured into dressed or greased moulds. The object of his research was to discover the ultimate effect of pouring the metal for brass-strip ingots into greased moulds, and the causes, mechanical, physical and chemical, which produced that effect, with a view to seeing how far the belief in the use of greased moulds was well founded. From a general survey of the literature on the subject it seemed probable that gases existed in metals in three states which might be named, provisionally, the chemical, the physical, and the mechanical.

Having given a survey of previous researches on the subject, MR. CARTLAND said that the conclusions drawn by previous observers from the results they had obtained were :—

(1) That the special brasses and forgeable brasses retain in the occluded state a considerable quantity of gas (from one to 30 times their volume), composed mainly of hydrogen, carbon monoxide, and carbon dioxide.

(2) That in sound specimens the occluded gas was almost entirely composed of hydrogen (more than 90 per cent.).

(3) That in unsound cast pieces the hydrogen was accompanied by a considerable proportion of carbon monoxide and a little carbon dioxide.

(4) That the bars obtained from hot rolling contained less than the cast pieces.

(5) That in the sound pieces the presence of occluded hydrogen, even in considerable quantity, did not have any bad influence on the mechanical properties of the forgeable brasses.

(6) That phosphor-bronze retained little of occluded gases, composed mainly of carbon monoxide and hydrogen, the presence of phosphorus appearing also to lessen for the bronzes, as for cast iron and steel, the solubility of hydrogen in the metal.

(7) That commercial tin, in blocks or sticks, retained a small volume of gas composed of carbon dioxide, hydrogen and carbon monoxide.

(8) That the metals referred to, when free from blowholes and cracks, did not exhibit a tendency to spilling such as one saw in silver, cast iron, and steel, etc.

Occluded gases, continued the speaker, could only be extracted by heating to the melting point *in vacuo*, or at least in a rarefied atmosphere. With regard to the mechanical state in which gases occurred in metals, namely, entrapped as bubbles of gas, Mr. H. Primrose, in a Paper read before the Institute of Metals in September, 1910, said : "The presence of the blowholes may be due either to slight dampness in the mould when the metal is cast into it, or the gases which form these holes may be actually dissolved in the metal when it is cast. They are often a source of trouble to the founder, casting after casting having to be scrapped on account of such holes, which usually do not show until the casting comes to be machined. They are often quite small and unequally scattered, and it can easily be understood how the tensile strength of the metal is reduced on account of these holes, even although the composition is perfectly correct, and the metal has been properly melted. A microscopic examination is the surest way of ascertaining the cause of blowholes. If these are clean and confined to the outer portion of the casting they are certain to be due to the steam formed within the mould, in which case a simple remelting brings the metal right. More often the pinholes in castings appear dirty under the microscope, and on polishing some brittle material is rubbed out causing serious scratching of the surface. This is due to segregations of included oxides, either of tin or of copper, which the small percentage of zinc has not been able to remove. Under this condition remelting is of no avail unless with the aid of some deoxidising agent such as phosphor-tin or phosphor-copper." Mr. Cartland was inclined to question the accuracy of Mr. Primrose's statement with regard to pinholes, as he found these holes to present the appearance of clean, bright, slightly spherical holes. They appeared to be due to the evolution during solidification of previously dissolved gases.

Coming to his own researches, Mr. Cartland said that he took a series of ingots, namely, two produced on a small scale in the laboratory and two of the ordinary commercial size, supplied by Messrs. Dugard Brothers, Vulcan Mills, Birmingham. Of each pair of ingots, one was cast in a mould dressed as in ordinary practice and the other in a mould free from dressing, and as clean as possible. A preliminary examination of the ingots showed that those in the greased moulds had a clean, light, yellow surface, very smooth, and with no surface blowholes and no oxidation films, the only irregularities being a few rather large inclusions of charcoal. Those cast in the clean moulds had a large number of blow-holes on the under surface, some of them being of considerable depth. The surfaces were also copper-coloured in parts, owing to a very distinct oxidation film. The fact that the blowholes appeared only on the under-surface suggested the possibility that they might be due to air entrapped by the mould in pouring. In the case of the greased mould the lubrication afforded by the dressing probably assisted the air bubbles entrapped in pouring to rise quickly to the surface and escape. He subjected the ingots to various physical, mechanical and chemical tests, and, ultimately, by melting *in vacuo* with the aid of specially constructed apparatus (which he described at length) he extracted the gases occluded in the ingots and subjected them to analysis. The results obtained from this series of researches showed that the surface of the undressed-mould ingot was pitted with blow-holes, whereas the surface of the dressed mould ingot was not. That might be explained quite independently of the gases involved, by the lubrication provided by the dressing assisting the air bubbles entrapped in pouring to rise. The dressed-mould ingot possessed superior mechanical properties. The rolling tests were, on the whole, in favour of the greased-mould ingots, though, as far as his investigations were concerned, that was not very well established. The results of the tensile tests were rather erratic, but taken as a whole showed no marked difference between the two bars. The hardness of the two ingots as measured by the scleroscope gave no difference, taking the mean results. The analyses

showed no particular difference, whilst the micro-structure of the two ingots was nearly the same, though that of the dressed-mould ingot was slightly larger, probably because the dressing of the mould prevented the metal from coming into sudden contact with the mould, and so avoided any chilling effect. The burning of the oil probably was also a factor. The specific gravity of the specimens was the same (about 8.44) with one exception—a dressed-mould specimen, which was less than the other and probably contained more blowholes. Neither of the ingots was seriously "spilly," although both contained some small blowholes which owed their origin to the fact that the solubility of gas was less in the solid than in the liquid metal, and that, therefore, a small quantity of gas evolved on cooling became entrapped as blow-holes in the solidifying metal. But the phenomenon of blowholes, apart from those on the surface in contact with the mould, was independent of the dressing or otherwise of the mould.

The quantity of gas dissolved, together with that in the form of blowholes, was approximately the same in each of the ingots, being about 30 per cent. of the volume of the metal. With regard to the nature of the gases dissolved, the results were too erratic for him to say whether or not there was any difference in the composition of the gases obtained from the two ingots. Roughly the composition of the gases obtained from both was :—

CO_2 = 3.5; O = nil; H = 59.0; CO = 27.6; CH_4 = 5.6; N, etc., = 4.8.

The results of his research, said the speaker, had led him to conclude that the gases dissolved in the ingots were not the cause of the difference in the mechanical properties. Dr. J. E. Stead in a well-reasoned Paper dealing with the theory of welding of blow-holes, had stated that blow-holes in steel ingots, the surfaces of which were clean, would weld up on rolling, whereas, if the blow-holes contained segregated oxide or impurity they would not weld. He (Mr. Cartland) put forward the suggestion that much the same thing occurred in the case of strip ingots, but that in this case the reducing gases through which the metal was poured took the place of the carbon in steel in reducing oxides which otherwise would tend to form a coating on the walls of the blow-holes and prevent welding on rolling. That theory had not yet been confirmed by the micro-structure, owing to the extreme difficulty of detecting zinc oxide or copper oxide in brass. The obvious advantage, however, resulting from the dressing of moulds was the elimination of surface blowholes.

Discussion.

The Chairman thought Mr. Cartland had done well in going to a practical manufacturer for his specimens, as those cast in a laboratory at a University or technical college were often suspected by the manufacturer of not being quite up to the mark. He thought, however, that Mr. Cartland's method for estimating the specific gravity might have been improved upon.

Professor Turner said that this was an example of investigation which could not very well be conducted at a works, because the amount of time, detail and apparatus necessary was such that it would not pay a manufacturer to undertake it. When he suggested the inquiry to Mr. Cartland, he thought it a comparatively simple matter, but it occupied far beyond the few months which at first appeared to be sufficient. The net result appeared to be that both of these ingots had the same amount and the same composition of gas, and therefore that the difference in the two was not a question of gas, but of some other condition. The explanation that had been suggested was chiefly a physical one, namely, that mentioned by Mr. Cartland in connection with the oiling of the side of the mould.

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The Use of Greased Moulds in Brass Casting.

By John Cartland.

At a meeting of the Birmingham Section of the Institute of Metals, held on Tuesday, November 14, Mr. G. A. Boeddicker (President of the Section) occupied the chair, and a Paper was read by Mr. John Cartland, M.Sc., Boyn Research Scholar, Birmingham University, on "The Gases in Cast Brass." The Paper was based upon original research by the author, and was illustrated by lantern slides and blackboard sketches.

It was customary, MR. CARTLAND said, to pour copper alloys through a reducing atmosphere, as without this precaution the metal would have inferior mechanical properties. To produce this reducing atmosphere the metal was usually poured into dressed or greased moulds. The object of his research was to discover the ultimate effect of pouring the metal for brass-strip ingots into greased moulds, and the causes, mechanical, physical and chemical, which produced that effect, with a view to seeing how far the belief in the use of greased moulds was well founded. From a general survey of the literature on the subject it seemed probable that gases existed in metals in three states which might be named, provisionally, the chemical, the physical, and the mechanical.

Having given a survey of previous researches on the subject, MR. CARTLAND said that the conclusions drawn by previous observers from the results they had obtained were :—

(1) That the special brasses and forgeable brasses retain in the occluded state a considerable quantity of gas (from one to 30 times their volume), composed mainly of hydrogen, carbon monoxide, and carbon dioxide.

(2) That in sound specimens the occluded gas was almost entirely composed of hydrogen (more than 90 per cent.).

(3) That in unsound cast pieces the hydrogen was accompanied by a considerable proportion of carbon monoxide and a little carbon dioxide.

(4) That the bars obtained from hot rolling contained less than the cast pieces.

(5) That in the sound pieces the presence of occluded hydrogen, even in considerable quantity, did not have any bad influence on the mechanical properties of the forgeable brasses.

(6) That phosphor-bronze retained little of occluded gases, composed mainly of carbon monoxide and hydrogen, the presence of phosphorus appearing also to lessen for the bronzes, as for cast iron and steel, the solubility of hydrogen in the metal.

(7) That commercial tin, in blocks or sticks, retained a small volume of gas composed of carbon dioxide, hydrogen and carbon monoxide.

(8) That the metals referred to, when free from blowholes and cracks, did not exhibit a tendency to spilling such as one saw in silver, cast iron, and steel, etc.

Occluded gases, continued the speaker, could only be extracted by heating to the melting point *in vacuo*, or at least in a rarefied atmosphere. With regard to the mechanical state in which gases occurred in metals, namely, entrapped as bubbles of gas, Mr. H. Primrose, in a Paper read before the Institute of Metals in September, 1910, said : "The presence of the blowholes may be due either to slight dampness in the mould when the metal is cast into it, or the gases which form these holes may be actually dissolved in the metal when it is cast. They are often a source of trouble to the founder, casting after casting having to be scrapped on account of such holes, which usually do not show until the casting comes to be machined. They are often quite small and unequally scattered, and it can easily be understood how the tensile strength of the metal is reduced on account of these holes, even although the composition is perfectly correct, and the metal has been properly melted. A microscopic examination is the surest way of ascertaining the cause of blowholes. If these are clean and confined to the outer portion of the casting they are certain to be due to the steam formed within the mould, in which case a simple remelting brings the metal right. More often the pinholes in castings appear dirty under the microscope, and on polishing some brittle material is rubbed out causing serious scratching of the surface. This is due to segregations of included oxides, either of tin or of copper, which the small percentage of zinc has not been able to remove. Under this condition remelting is of no avail unless with the aid of some deoxidising agent such as phosphor-tin or phosphor-copper." Mr. Cartland was inclined to question the accuracy of Mr. Primrose's statement with regard to pinholes, as he found these holes to present the appearance of clean, bright, slightly spherical holes. They appeared to be due to the evolution during solidification of previously dissolved gases.

Coming to his own researches, Mr. Cartland said that he took a series of ingots, namely, two produced on a small scale in the laboratory and two of the ordinary commercial size, supplied by Messrs. Dugard Brothers, Vulcan Mills, Birmingham. Of each pair of ingots, one was cast in a mould dressed as in ordinary practice and the other in a mould free from dressing, and as clean as possible. A preliminary examination of the ingots showed that those in the greased moulds had a clean, light, yellow surface, very smooth, and with no surface blowholes and no oxidation films, the only irregularities being a few rather large inclusions of charcoal. Those cast in the clean moulds had a large number of blow-holes on the under surface, some of them being of considerable depth. The surfaces were also copper-coloured in parts, owing to a very distinct oxidation film. The fact that the blowholes appeared only on the under-surface suggested the possibility that they might be due to air entrapped by the mould in pouring. In the case of the greased mould the lubrication afforded by the dressing probably assisted the air bubbles entrapped in pouring to rise quickly to the surface and escape. He subjected the ingots to various physical, mechanical and chemical tests, and, ultimately, by melting *in vacuo* with the aid of specially constructed apparatus (which he described at length) he extracted the gases occluded in the ingots and subjected them to analysis. The results obtained from this series of researches showed that the surface of the undressed-mould ingot was pitted with blow-holes, whereas the surface of the dressed mould ingot was not. That might be explained quite independently of the gases involved, by the lubrication provided by the dressing assisting the air bubbles entrapped in pouring to rise. The dressed-mould ingot possessed superior mechanical properties. The rolling tests were, on the whole, in favour of the greased-mould ingots, though, as far as his investigations were concerned, that was not very well established. The results of the tensile tests were rather erratic, but taken as a whole showed no marked difference between the two bars. The hardness of the two ingots as measured by the scleroscope gave no difference, taking the mean results. The analyses

showed no particular difference, whilst the micro-structure of the two ingots was nearly the same, though that of the dressed-mould ingot was slightly larger, probably because the dressing of the mould prevented the metal from coming into sudden contact with the mould, and so avoided any chilling effect. The burning of the oil probably was also a factor. The specific gravity of the specimens was the same (about 8.44) with one exception—a dressed-mould specimen, which was less than the other and probably contained more blowholes. Neither of the ingots was seriously "spilly," although both contained some small blowholes which owed their origin to the fact that the solubility of gas was less in the solid than in the liquid metal, and that, therefore, a small quantity of gas evolved on cooling became entrapped as blow-holes in the solidifying metal. But the phenomenon of blowholes, apart from those on the surface in contact with the mould, was independent of the dressing or otherwise of the mould.

The quantity of gas dissolved, together with that in the form of blowholes, was approximately the same in each of the ingots, being about 30 per cent. of the volume of the metal. With regard to the nature of the gases dissolved, the results were too erratic for him to say whether or not there was any difference in the composition of the gases obtained from the two ingots. Roughly the composition of the gases obtained from both was :—

CO_2 = 3.5; O = nil; H = 59.0; CO = 27.6; CH_4 = 5.6; N, etc., = 4.8.

The results of his research, said the speaker, had led him to conclude that the gases dissolved in the ingots were not the cause of the difference in the mechanical properties. Dr. J. E. Stead in a well-reasoned Paper dealing with the theory of welding of blow-holes, had stated that blow-holes in steel ingots, the surfaces of which were clean, would weld up on rolling, whereas, if the blow-holes contained segregated oxide or impurity they would not weld. He (Mr. Cartland) put forward the suggestion that much the same thing occurred in the case of strip ingots, but that in this case the reducing gases through which the metal was poured took the place of the carbon in steel in reducing oxides which otherwise would tend to form a coating on the walls of the blow-holes and prevent welding on rolling. That theory had not yet been confirmed by the micro-structure, owing to the extreme difficulty of detecting zinc oxide or copper oxide in brass. The obvious advantage, however, resulting from the dressing of moulds was the elimination of surface blowholes.

Discussion.

The CHAIRMAN thought Mr. Cartland had done well in going to a practical manufacturer for his specimens, as those cast in a laboratory at a University or technical college were often suspected by the manufacturer of not being quite up to the mark. He thought, however, that Mr. Cartland's method for estimating the specific gravity might have been improved upon.

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sumed to be nothing but air entrapped on the surface owing to the fact that the metal stuck on, as it were, to the mould. With regard to the origin of the gas involved, he believed that the gas obtained in his experiments was the gas in solution, and not the gas that formed the blow-holes, because there were very few blow-holes, especially when using a turned ingot. All metals contained gas in this way. Copper in all stages of its manufacture had been found to contain gas, and many analyses showed that the gas was something of the same sort. They must look back to the first stage, the smelting of the copper, and the gas there taken up was held in solution in melting at ordinary temperatures. Why it had not decomposed, he could not say at all. It might possibly be due to some error in his method. He thought that in the majority of the best results (with no leak in the apparatus) the quantities were even less than two cubic centimetres, down to 1.3 c.c. He believed the gases were originally there in the copper itself, and possibly in the zinc. Mr. Hudson had pointed out that included oxide might be the cause of the mechanical difference in the rolling properties. There were only two instances of difference between the two ingots, the dressed-mould ingot having better rolling properties than the one from the undressed mould. He quite agreed that included oxides might be the cause of the trouble. In answer to Mr. Sheppard's question, he must confess his lack of knowledge of the subject in not knowing the fact mentioned by Mr. Sheppard. With regard to dressing the bottom and not the top of the ingot moulds, supposing there was no other difference—and these inclusions of oxide were not the cause of the mechanical differences—supposing the only trouble was the surface blow-holes which were caused by entrapped air or gas, he thought it extremely probable that lubricating the bottom surface would eliminate these blow-holes. With regard to the Chairman's account of Lord Rosse's experience he thought that the same thing might have occurred there as occurred in the ordinary strip ingot, that the metal gripped the mould and formed a hollow round the bubbles. If there was room for the air to pass while the metal was still plastic and the air could escape underneath, the metal would press it out. (The Chairman : that is so.)

Mending Melting Furnaces.

By Walter J. May.

Where melting furnaces have any fair amount of work they burn away, as a matter of course, and from time to time have to be patched up. Re-lining or rebuilding in the end becomes necessary, unless there has been such provision made as to make an indefinite number of fresh linings possible. Naturally, the first point to be considered is economy, but generally this is considered from the wrong end, low first cost usually being the point most largely considered. With furnaces the question of after repairs always stands out prominently, however, and the facility with which these can be done has a considerable bearing on costs. If, for instance, we take a cupola subjected to rough, heavy work and melting hard iron rapidly, we find that not only does the lining burn away in the neighbourhood of the tuyeres, but there is a tendency towards the cylindrical furnace becoming egg-shaped and bellying out, this altering both the melting capacity and coke consumption. By keeping the bad places daubed up with gannister some relief can be obtained, as most persons handling this class of melting furnace know, but eventually re-lining has to be done.

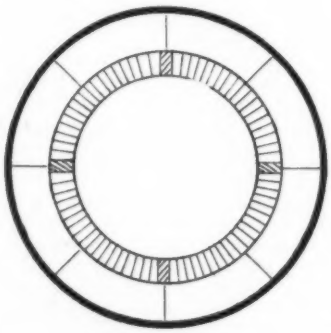


Fig. 1.

Now, it is just on this re-lining that a lot depends as to cost, because if whole segment blocks only have been used, practically the whole of the cupola's inside has to be taken out and replaced, whereas if there is an inner lining of arch-bricks, only this will have to be taken out and replaced, making the job a fairly easy and economical one. With crucible furnaces, also, one may just as well have the fire-brick lining arranged to come out easily as to build it into the walls so that re-lining really means the practical re-construction of the furnaces. Better still would it be to line the brick furnaces with fire-brick slabs 4 in. thick, as in that case there would be no joints to be seriously affected by the fire. In fact, bricks burn away from the edges in this class of furnace, and provided this can be done away with, or the joints made so close that they will not catch the heat unduly, the life of the furnace is increased very considerably. All parts of a furnace exposed to the fierce heat of the fire of a melting furnace should be smooth, and the joints should be close. For this it is desirable that the

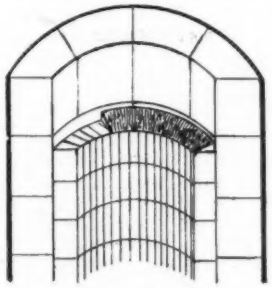


Fig. 2.

should be rubbed to remove any inequalities. Rubbing fire-bricks is pretty hard work, and takes a long time, and it is always the better plan to pay a slightly higher price per thousand and have picked bricks.

In cupola linings the cross-sectional arrangement should be as shown in Fig. 1, the outer ring being either of segment blocks or bricks, as found most convenient; but, of course, the centre ring should be of arch bricks on end, with either two or four ordinary rectangular bricks, as indicated, these being easy to get out and thus allowing repairs to part of the ring where necessary. A portion of such a lining is shown vertically in Fig. 2, this having a cast-iron ring on top of the inner lining to prevent wear. This iron ring is sufficiently effective for the purpose. The bricks should be put in as tightly as possible, and be grouted together with fire-clay in a sloppy condition, the bricks, of course, being well wetted before being put in their places. The smoother and thinner the joints the more durable will the work be, because if there is nothing to catch the descending charges the less will be the friction. If a fire-clay tube could be used this would probably be better than bricks if it were well rounded up with fire-clay, but such a tube would be difficult to deal with, owing to its weight and general awkwardness, while it could not be got into all makes of cupolas. Failing this, the next best thing is the arch-brick lining, provided the bricks are square and true and are put in with the thinnest possible joint of fire-clay. Possibly silica bricks jointed with very finely grounded gannister

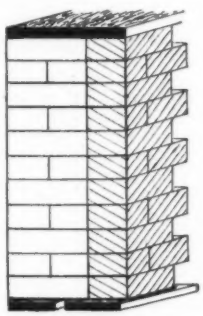


Fig. 3.

would resist heat better, but the expense would scarcely be justified, as with ordinary work good fire-bricks stand well, especially where daubing up with finely-ground, well-kneaded gannister is resorted to.

In regard to daubing, it may be as well to mention that the gannister should be ground to some degree of fineness, that it should be maintained in a moist state in the bin, and that the portion required for use should be well trodden or otherwise kneaded into a tough putty-like mass; the tougher the better. On the whole, it is rather a mistake to use the rough gannister so often provided on account of its slightly less cost, as owing to its hurting and sometimes cutting the hands of the person applying it, sufficient force is not used in beating it on to the cupola or furnace lining. The consequence is that it folds over and comes down with the charge, and then comes off with the slag, a process which is unprofitable, if not worse.

In applying a daubing of gannister, the first thing is to chip off all slag and get the surface of the bricks clean; then a wetting with good adhesive clay wash should be put on, and following this the gannister should be applied and beaten in tightly while keeping the surface as smooth as possible. Necessarily the layer put on will to some extent vary in thickness, as some parts of the lining wear more than others, but in no case should the layer be too thick, as this does not tend to durability.

In the case of ordinary bricked crucible furnaces there should be sufficient bearing provided to enable the fire-brick lining to be carried up independent of the rest of the brickwork, a 4½-in. lining being strong enough for all ordinary purposes. One-inch thick cast-iron plates may very well be used for bearers, and in section the work would look very much as shown in Fig. 3, from which it will be seen that re-lining can be done without much trouble. However, a better lining would be one formed of fire-clay blocks or tiles of about 4 in. in thickness, and these could be made as shown in the cross section, Fig. 4, the angles being made up with fire-clay and the backs of the tiles being grouted in with the same material.

In running crucible furnaces it is desirable to clean off slag or clinker each day while the stuff is

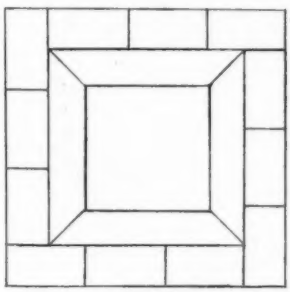


Fig. 4.

hot, and a flat "slice," as boiler-men call it, should be used for the purpose. The cleaning of the furnaces tends to increase the durability of the lining, but as in the ordinary course of events wear is certain to occur, daubing up with gannister will have to be resorted to in places for some time before re-lining is done. The method of putting on the gannister is the same as in a cupola, but usually it has to be kept thinner and smoother on the surface, as the draught conditions are different.

In some places crucible furnaces last longer than others, even with equal amounts of metal melted. In the one case better bricks and better workmanship are used in putting the linings together, and probably the methods of the firemen differ somewhat, some men doing their work in a less rough manner than others. A further factor is the quality of the coke used, that which contains a large percentage of ash making more slag or clinker than that which is clean, and usually the dirtier fuel makes a slag that is more adherent to the walls of the furnace than does the cleaner one. Coke containing much sulphur is generally bad for both crucibles and furnace linings, and the small saving in first cost is more often than not over-balanced by expenses incurred through its use.

In all repair jobs two losses usually occur, the first being the cost of the repairs, and the second the loss occasioned by the apparatus being out of work during the time the repairs are being effected, and more often than not the second set of costs is the more serious of the two.

Steel shelving for the storage of patterns in the foundry has the important feature of being fireproof, while it can be constructed so as to be readily adjustable, allowing a minimum of waste space.

A Safety Foundry Ladle.

Constant trouble and risk of accident with the catch on a foundry ladle led to the device illustrated. The ladle was of the type mounted on a bogie running on rails on one side of the foundry, feeding the hand ladles at convenient points. When out of use a bolt was formerly slid over a square on the end of the trunnion to prevent the ladle from being overturned accidentally. It was very difficult for various reasons to keep this in efficient repair, and at last the arrangement was finally condemned when an accident actually occurred, due to its inefficiency. The sliding bolt was entirely done away with, and on to the squared trunnion was shrunk and pinned a bar A about a foot long. One end of this bar rested when the ladle was vertical on an adjustable screw B. Beneath the other end of the bar was a catch C, pivoted on the pin D, and with sufficient potential movement to enable it to nicely clear the end of the bar A when required. On the catch C was loosely pivoted a lever E, with a weight F attached. That comprised the whole apparatus, the action of which can best be described by following the figures in their order.

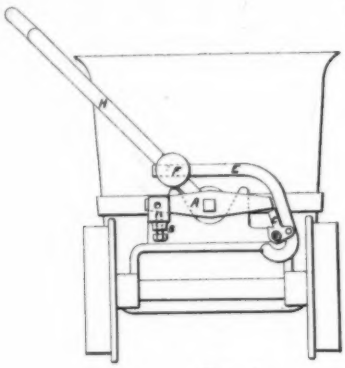


Fig. 1.

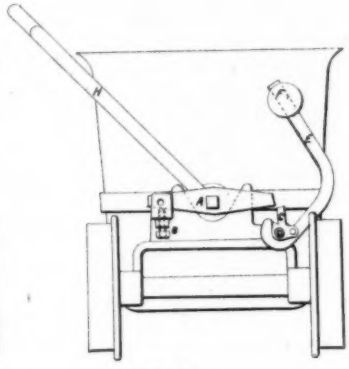


Fig. 2.

Fig. 1 shows the ladle in its vertical position, locked so that it cannot move when being filled or removed from one place to another. H is the handle by which the apparatus is craned, and has nothing to do with the apparatus at all. It may here be mentioned that the ladle can be lifted clear of the bogie at any time when required without disturbing any part of the safety catch.

When it is desired to pour the molten metal the weight F, and with it the lever E, are moved into the position shown in Fig. 2, in which position it will just remain, and only just, the slightest knock returning it to the position Fig. 1, again locking the ladle. In Fig. 2 it will be seen that the catch is removed and the ladle is free to be turned on its trunnions for pouring. As soon, however, as the ladle is tilted and before pouring begins, the bar A comes into contact with the lower part of the lever E carrying the weight (see Fig. 3), and immediately, upsetting its equilibrium, causes it to fall into the position shown in Fig. 4. The metal can now be poured from the ladle until it is quite empty.

When the ladle is returned to its upright position the bar A passes the catch C, lifting the lever E and the weight F, after which the weight causes the catch to fall into the position Fig. 1, locking the ladle as before. Suppose, however, for some reason or another the ladle is not quite raised to its vertical position to allow the catch to fall into place, there is provided a supplementary notch on the catch C and nearer its fulcrum, which will prevent the ladle from being turned further than the position shown in Fig. 5, unless the weight be intentionally raised; so that the metal cannot be accidentally poured.

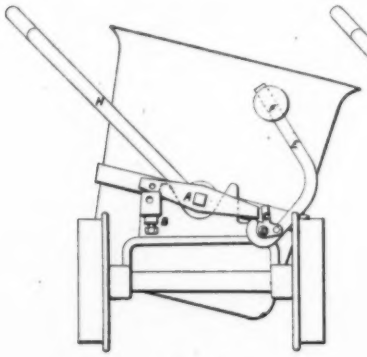


Fig. 3.

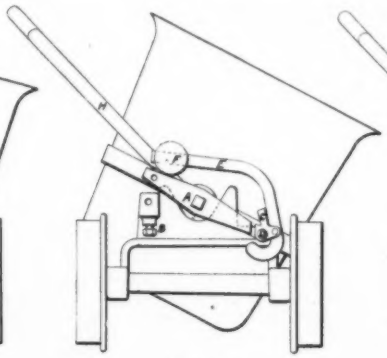


Fig. 4.

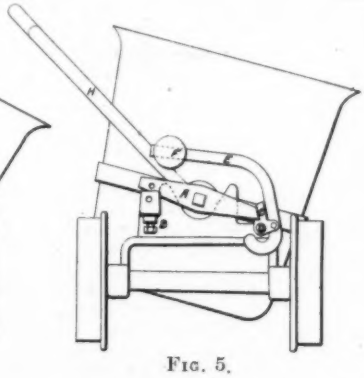


Fig. 5.

This safety catch possesses the following advantages over the usual sliding bolt:—It cannot be unintentionally displaced; it automatically locks the ladle every time and allows no rock at all; it is adjustable for the wear of the trunnions and other parts, and does not interfere with the handling of the ladle by the crane; it does not wear badly nor get out of order.

The illustrations show the ladle for pouring on the one side only; all that is necessary in order to make it pour either way is to replace the adjustable stop B by another catch similar to the catch C, and connected to the same weight and lever by a bar from the top of one catch to the bottom of the other, so that they work in unison.

Report of the Royal Mint.

The annual report of the Royal Mint for 1910, which has just been published, gives an account of the enormous operations of this Department during the past year. No less than 371 tons of gold were melted during the 12 months, this amount being more than double the average of the ten years 1899-1908.

A large quantity of nickel is melted at the Mint for coinage for East and West Africa. The quantity of gold, silver, bronze and nickel melted during the year amounted to 1,251 tons, and even then the demand for coinage was so great that 250 tons of bronze blanks had to be purchased from contractors. The total number of coins struck during the year was 158,204,241, the value of these amounting to £28,040,217, which is a record for the Royal Mint.

Some very important changes have been made in the methods of melting the various metals used for coinage. Preliminary experiments on the use of gas and oil instead of coke have been in progress since early in 1909. Electric furnaces were also experimented with. In connection with these experiments a number of visits were made to factories both in London and the provinces, where oil or gas was used for melting purposes, and the Superintendent was directed in January, 1910, to visit the United States and Canada. Oil furnaces burning both petroleum and creosote oils were tested under very varying conditions, and with air at pressures varying from 2 to 25 lbs., but it was finally decided that liquid fuel was unsuitable.

In the experiments with ordinary town's gas several systems were tested, involving the use of gas at ordinary and high pressures, combined with variations in the pressure of the air, and the burner ultimately adopted was made by Mr. S. N. Brayshaw, of Manchester. For the Brayshaw burners in use at the Mint the gas is taken at the ordinary pressure in the main (about 3 in. of water) and mixed with air from a powerful blowing engine at about 2 lbs. pressure. With care the noise of these burners can be reduced sufficiently to be unobjectionable; the furnace linings compare very favourably with those hitherto used for coke in regard to endurance, and the crucibles used for gold are found to last longer (each crucible serving for an average of 18 heats as against 12 when coke is used). The adoption of gas as a fuel in place of coke has been accompanied by several incidental economies, and it is interesting to note that the present charge for fuel averages about 4¼d. per cwt. of standard gold bullion as against 7d. when coke was used. It should be added that in this statement the fuel needed to warm up the furnace in the morning has been eliminated, but, including this, the cost rarely exceeds 5d. per cwt. on a day's work. During 1910 the Mint installed 16 gas-heated furnaces, each capable of taking a 400-lb. crucible, and fired with Brayshaw gas burners. These 16 furnaces have a maximum capacity of 2¾ tons of sterling silver, or 2½ tons of bronze per melt, and four melts of silver, or three of bronze, can be made in an ordinary working day (8 a.m. to 6 p.m.). Also five furnaces, similarly gas-heated, but of a smaller size, are in use for melting gold.

Considering the large quantity of metal melted at the Mint, it will be seen that a very substantial saving in the cost of fuel alone has been effected for the nation by the use of gas. The incidental economies are, however, still greater. The cost of carting and handling both coke and clinker is saved, and the room formerly required for the storage of them is set free. The expenditure on crucibles, which is a large item, has been reduced by 33 per cent. The work of melting is less laborious, the loss of metal is much reduced and the bars cast are better and more uniform.

Steel for Ingot Moulds.

Writing on this subject in "Stahl und Eisen," A. Thiele, of Rothe Erde, states that the replacing of cast-iron moulds by steel has only recently been experimented with, and what results have been obtained have not been very encouraging. The chief defect has been that after a few heats the moulds deteriorate, the cross-section changes and they become useless for further work. Using different kinds of steel did not obviate this difficulty. Mr. Thiele finally succeeded in solving the problem by reinforcing the deterioration zones by suitable sections that were cast in the body of the metal, which balanced the tendency toward contraction.

Moulds produced by this process, which is patented in Germany, stand about 250 heats. These moulds lost 8.8 to 11 lb. per ton of steel, which was about 6.6 lb. per ton less than with the old cast-iron moulds. The lower part of an iron mould is often badly attacked, causing enlargement of the lower end of the ingot, but this is said not to be so with steel moulds, for the lower part remains of the same section throughout their life.

In addition to the saving of 6.6 lb. of the mould lost per ton of steel, it is claimed that in many cases the moulds can be made cheaper than those of grey hematite iron, and when used up they are worth more as scrap. The moulds are made similarly to those of cast iron. For reinforcement I-beam 2.35 in. or mine rails 2.56 in. were used. These were cut in lengths of about 27 in., and placed on each of the four sides lengthwise in groups of three parallel to each other. They were fastened in the foundry mould with nails, so that on the outer side of the finished mould they would be exposed to the air and would be covered on the inner side with a layer of steel from 0.6 in. to 0.78 in. thick. As regards the steel, either basic open hearth or Bessemer low-carbon steel was found to be suitable. When using the moulds water cooling ought to be avoided if possible. The moulds are not made thicker than in the case of cast iron.

German Foundrymen's Prize Contest.

The German Foundrymen's Association (Vereins Deutscher Giessereifachleute) will award three prizes—1,000, 500 and 300 marks respectively—to any person giving the best answer to the following question: "Has there been made any decided progress in the last twenty years in the construction and running of cupola furnaces?" Special value is put on the economy of the furnaces and the quality of the molten metal. The hygienic point should also be defined. The judges are: F. Wust, Aachen; W. Schlenker, Berlin; A. Nachtweh, Hanover; C. Gilles, Berlin; F. Meyer, Wintherthur; C. Henning, Mannheim; H. Adammer, Hengelo; C. Humperdinck, Durlach; H. Dahl, Berlin; F. Bork, Berlin. The conditions governing the contest can be obtained from the Office of the Society, 60, Sybel Street, Berlin Charlottenburg, Germany.

Foundry Plant and Equipment.

Automatic Ring-Hardening Machine.

Herewith illustrated is a machine for the automatic hardening of spinning rings. The heat is developed by gas under pressure, and the feeding and delivery of

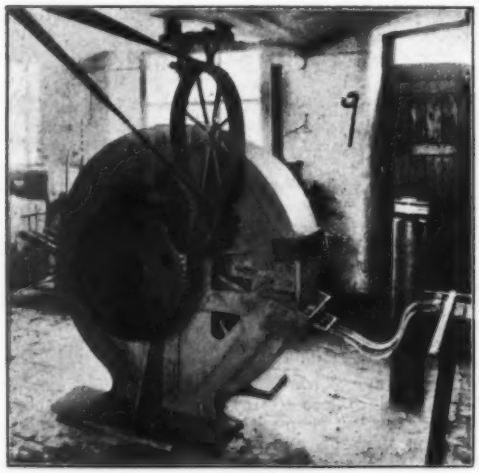


FIG. 1.—RING-HARDENING MACHINE.

the furnace are entirely automatic. The apparatus can deliver 600 rings per hour and the only labour required is a boy to keep the chute filled. The driving

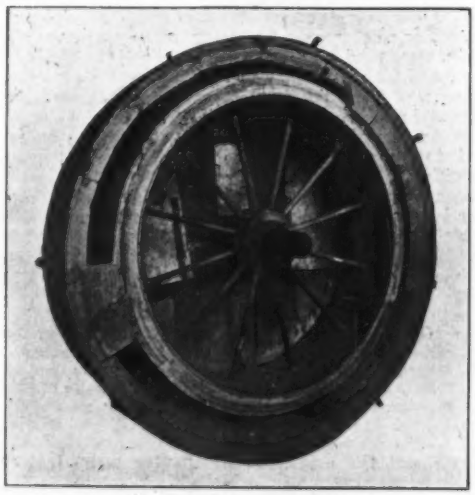


FIG. 2.—INTERNAL VIEW OF RING-HARDENING MACHINE.

is direct from the line shaft through spur and worm gear, giving four revolutions per hour to the working surface.

The internal arrangement is practically a pulley covered with a substantial layer of special firebrick in which a series of studs are screwed. The feeding arrangement is in the form of a chute on which the rings are placed, and as each stud comes up it takes on a ring which is carried round. The heat at the mouth of the furnace is approximately 300 degrees Cent.

The rings are carried along through a rising temperature, and directly they get into the hottest zone, which can be regulated to the correct hardening point of the steel in question, they automatically drop out into either oil or water, as the case may be. A non-oxodising heat is obtained by the use of three high-pressure gas burners, only sufficient air being drawn through for combustion purposes. Accordingly, every ring that goes through is absolutely free from scale. An arrangement has been made for a pyrometer attachment to ascertain the temperature from three points either side or in the centre.

The inner circle is thoroughly well protected, as shown in Fig. 2, by a substantial thickness of brickwork. The whole is well protected by heavy cast-iron sides and sheet-iron cylinder, and has been both designed and manufactured by The Manchester Furnaces, Limited, Globe Works, Carruthers Street, Ancoats, Manchester.

Self-Contained Sand-Blast Tumbling Barrel.

A new design of self-contained sand-blast tumbling barrel recently brought out by the London Emery Works Company, of Park, Tottenham, London, N., is illustrated herewith. Previous designs of tumbling barrels constructed on the pressure system have had the disadvantage of great wear and tear on the piping between the sand-blast apparatus and the tumbling barrel. Further, there was a corresponding decrease in the efficiency of the sand stream, owing to the continual alteration of its direction by the various sharp bends in the piping it traversed before reaching the nozzle.

In the apparatus under notice, by attaching the sand-blast apparatus to the side of the outer casing, the machine is made self-contained, which not only saves the expense of the intermediate india-rubber hose, but also reduces the amount of floor space required. This arrangement has also been found to increase the efficiency of the barrel considerably, as the distance from the mixing pipe to the nozzle is the shortest possible. Another advantage of this construction is that it allows all the valves to be conveniently placed, and there is less time lost in filling, starting and stopping, and cleaning the valves should they become choked.

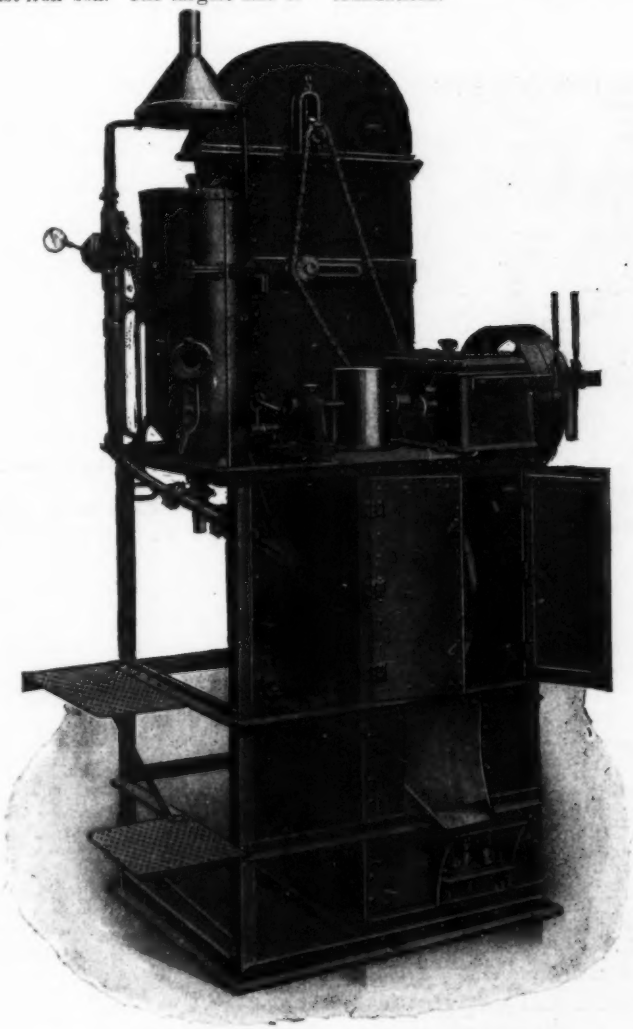
The outer case encloses a perforated tumbling barrel revolving on rollers. On the inside of the barrel a number of pieces of angle iron are fixed, which throw the castings in different directions as the barrel revolves, and thus prevent any of the castings from simply slipping round the inside and escaping being thoroughly sand-blasted. According to the size of the barrel, nozzle pipes are fitted in an inclined direction, which, in consequence of the swinging motion imparted to them, thoroughly blast the whole of the contents. The opening provided in the barrel for

charging and discharging the castings is also used for changing the chilled-iron nozzles, which are held in position simply by a union.

Underneath the barrel an inclined perforated plate is fixed, on to which the castings fall as discharged. They are then delivered through the outlet shown, into a suitable receptacle underneath. Beneath the plate is a spiral conveyor, which carries the used sand to a bucket elevator. The driving arrangements of the barrel and nozzles are placed on top of the outer casings, in a closed cast-iron box. The largest size of this apparatus which the Company make is fitted with two conveyors and double elevators to deliver the sand into the two-pressure sand-blast apparatus placed on each side of the barrel. If preferred, the barrel can be driven from the elevator at the back, instead of from the side, as shown.

The barrel rotates sufficiently slowly to allow the cover to be removed, the barrel charged and the cover replaced without bringing it to a standstill. The sand or shot falling out of the barrel with the castings, falls through the perforations of the slide. Whilst the barrel is being discharged and reloaded, the two-pressure sand-blast apparatus is also refilled with sand of shot by opening the filling valve.

The sand or shot not reduced to dust falls through the perforations of the barrel and outlet shoot into the spiral conveyor, and thence by the elevator it is returned to the two-pressure sand-blast apparatus for further use. The sand reduced to dust is removed by an exhaust fan. The apparatus being self-contained and resting on an angle-iron framework, requires no foundations.



New Design of Sand-blasting Apparatus for Castings.

Combined Squeezer and Jolt-Ram Moulding Machine.

The portable combined jolt-ramming and squeezer moulding machine illustrated herewith, is now being built by the Arcade Manufacturing Company, Freeport, Ill., and is adapted for light work. It can be used as a combined squeezer and jolt-rammer or as

a simple squeezer for light work and as a jolt-ramming machine without the squeezer for comparatively heavy work.

Fig. 1 shows the machine in position for squeezing a mould, with the head swung forward, directly over the table, while Fig. 2 shows the head tilted back in position for jar-ramming the mould. The piston which serves to jar-ram, also squeezes the mould with its upward stroke when the head is in its forward position. When the head is thrown forward, the valve controlling the jolting mechanism is closed, and the valve which actuates the squeezing movement is automatically opened. When making a mould in which the jolt-ramming and squeezing operations are employed, the flask, after being filled with sand, is jolt-rammed on the table of the machine, the

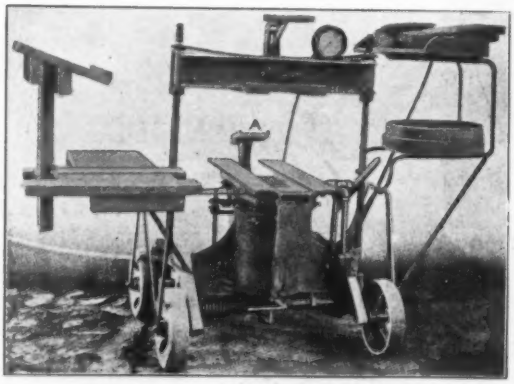


FIG. 1.—SQUEEZING POSITION OF COMBINED SQUEEZER AND JAR-RAMMING MACHINE.

squeezing head in the meantime being tilted back. After jolt-ramming and striking off the mould, the squeezing board is adjusted, the head swung forward, and the mould is squeezed. After lowering the piston, the head is tilted back and the pattern vibrator is set in motion by the knee pad at the front of the machine. When the knee pad is

FIG. 2.—JAR-RAMMING POSITION OF COMBINED SQUEEZER AND JAR-RAMMING MACHINE.

operated, the cope rest, shown in Fig. 1 at A, is moved forward, and the cope half of the mould is set on this rest while the pattern is being withdrawn from the mould. The machine is equipped with a stand for holding match-plates and bottom boards at the left and a riddle and tool rack at the right. The head is counterbalanced by a spring to insure its easy backward and forward movement.

Overhead Travelling Revolving Foundry Crane.

In the use of overhead travelling cranes in foundries, which usually consist of a number of shops or sheds lying parallel to each other, there is always the disagreeable feature present that there is a strip of the shed on one side, on the boundary of the two sheds under the crane travelling rails, which cannot be served satisfactorily by the crane hook. This disadvantage is caused partly by the centre of the travelling rails not falling exactly in the centre of the supporting columns of the sheds, the crane rails being, in fact, projected into the shed for a considerable distance; but, also, the centre of the crane-hook must be arranged at a certain distance from the crane rails, this distance depending upon the dimensions of the crab. It is therefore evident, especially when two sheds spanned by travelling cranes lie next to each other, that a considerable portion of the foundry is precluded from being served by the crane.

Recently, however, a travelling crane with revolvable jib has proved to be very suitable, this being constructed so that the jib can be turned and guided underneath and between the crane-track girders. This crane not only serves the parts of the shops under the travelling-track girders which were unattainable with the old types of cranes, but also takes up loads with the hook in the side sheds, so that these loads can be transferred from one shed to the other. The following is a brief description of a revolving crane plant of this type executed by The Deutsche Maschinenfabrik A. G., Duisburg, Germany, for the foundries of Messrs. Thyssen & Company, of Mülheim-on-Ruhr, the installation consisting of two revolving travelling cranes of 30 tons' lifting capacity and two smaller cranes of 15 tons' lifting capacity. As the two types of travelling cranes of the different lifting capacities are quite similar in their constructional features, attention will be confined to those of 30 tons' lifting capacity.

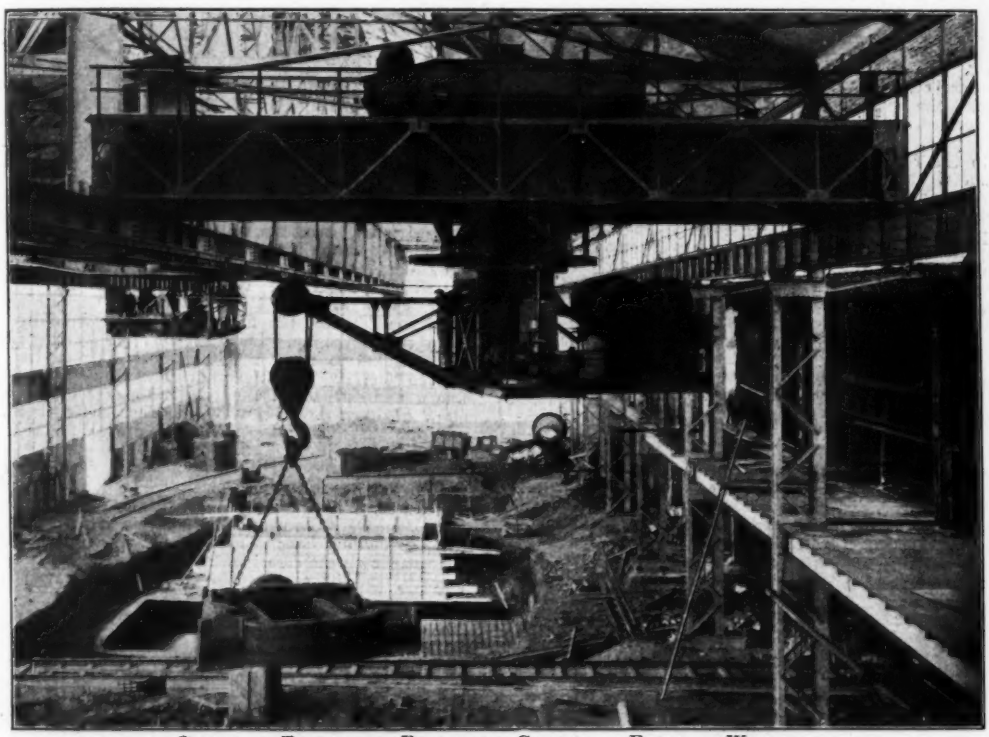
The new large main shop of Messrs. Thyssen & Company's foundry, which is well lighted, partly by a glass roof and partly by glass sides, is divided into two crane fields by the crane-travelling tracks suspended from the roof girder work. In building the shop in this manner a large open shed is obtained, unobstructed by supporting pillars either for the roof or cranes, thus enabling every inch of the shed to be taken advantage of, and in no way hindering the revolving of the jibs of the cranes. The working space is divided so that on one side the lighter castings are made, which can be dealt with by the cranes of lower capacity, whilst on the other side, where the more heavily constructed lifting appliances are erected, the heavy castings can be made. Accordingly, on one side of the shed, there are two cranes of 15 tons' lifting capacity, whilst on the other there are two cranes of 30 tons' capacity. By employing two crane hooks, therefore, one is in a position on side of the shed to deal with pieces up to 30 tons in weight, and on the other side to lift weights up to 60 tons. As the h.p. and working speeds of the motors for each crane are exactly the same, the two cranes can work together in lifting one piece.

The girder of the 30-ton revolving travelling crane is constructed as a solid-plate girder with parallel girths, and secured against lateral deflections by means of rigid travelling platforms, one of which carries the crane travelling gear. The platform girder is made up of lattice work. On the crane girder runs the travelling crab carrying the revolving arm, which crab is propelled by spur-wheel gearing operated by a motor. The double-armed jib is suspended from a centre pivot of forged steel, which is fitted on an easily accessible ball-step bearing on the crab. The nose of the jib carries the rope pulley with the load hook, whilst the back part is arranged as a counter-weight arm, on which

the driving gear for the lifting of the load, as well as a counter-weight of iron and concrete, are fitted. For accomplishing the revolving movement of the jib the driving motor, through an enclosed-worm intermediate gearing, works on a pinion with vertical axis, which in turn runs on a toothed wheel and so effects the turning movement of the revolvable jib suspended to the crab. Opposite the driving motor for the driving gear, on the other side of the revolving column, the crane driver's place and the governing apparatus are arranged. The stand for the driver is fixed somewhat on one side of the front jib-arm, so that he has an uninterrupted view over the entire working field of the hook.

The lifting gear, which acts at the same time as the counter-weight for the balancing of the load, consists of a driving motor, two spur-wheel gears, of which the first runs in an enclosed oil box, and the rope drum for winding up the load rope which is guided by the pulley fitted on the nose of the jib. The braking of the excessive power is effected by an electro-magnetically operated holding brake. The tipping movements of the jib and of the crab respectively are taken up by the upper neck-bearing, as well as by four wheels which are fastened on the structure from which the crab is suspended and are supported against the lower girth of the crane girder.

The apparatus above described is a good example of the manner in which an overhead travelling crane with revolving jib can serve the entire floor of a foundry, and permit of castings being easily taken from one part of the shop to the other.



Overhead Travelling Revolving Crane for Foundry Work

Ferro-Tungsten in the Electric Furnace.

With the method employed by the Electric Furnaces & Smelters, Limited, at their works at Luton, it is claimed to be quite possible to produce ferro-tungsten with a power consumption of 4,000 k.w. hours per ton of metal, and this feature makes it possible to carry out the manufacture quite economically even in such an industrial centre, where no natural power resources are to be found. The company has already produced several tons of this valuable metal in their new works. The power, as supplied by the Luton Corporation power supply station, is delivered at 500 volts d.c. This is being converted into alternating current of high density and low voltage by means of a motor generator set, provided with suitable regulating devices. Three large furnaces are operated alternatively, thus utilising the full power of the plant. It is intended to extend this in the near future with two more furnaces, each of about three times the capacity of the present ones. The ore is ground in a suitable ball mill and mixed with the reducing agent and flux in the required proportions, and fed into the furnaces. After the smelting is completed, the resulting blocks of metal, weighing 6 cwt. to 8 cwt., are lifted out by means of a crane and broken into large lumps, which are subsequently cleaned and broken up into walnut size and sorted ready for the market. Trials are also being made with other high-grade alloys, such as ferro-uranium and ferro-tantalum.

Jacobs Brothers & Richmond, Limited, engineers, iron and steel merchants, of Dock House, Billiter Avenue, E.C., have transferred their Belgian business to 25, Rue Henri Maus, Brussels.

Mr. H. R. Witting' engineers' agent, is removing from 9, Southampton Street, Holborn, London, W.C., to more extensive premises at 41, Berners Street, London, W.

Messrs. E. Qualter, A. Smith & H. Smith, carrying on business as engineers and ironfounders, at Barnsley, under the style of Qualters & Smith Brothers, have dissolved partnership, so far as regards Mr. E. Qualter.

Inventions.

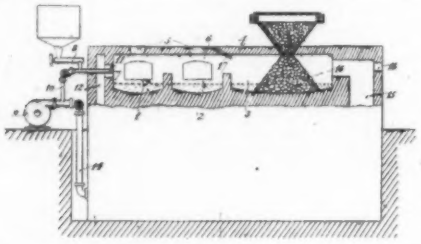
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

23,575.*Moulding and similar machines. Daimler Company, Limited, and A. Wardle.
24,750. Automatic turning machines for "finishing" cast-metal hollow-ware. Thomas Holcroft & Sons, Limited, A. Holcroft, and W. B. Challen.
24,834. Appliance for use in drawing patterns in sand moulding. T. C. Longfield.
24,845. Removing fallen sand from or cleaning moulds prior to casting. J. M. Lockhart.

Abstracts of British Patent Specifications recently accepted.

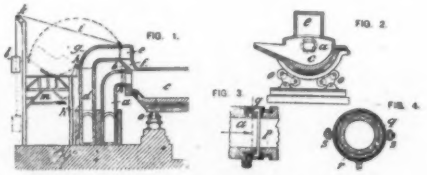
29,710 (1910). *Manufacture of Iron and Steel.* M. J. Davidsen, 5, rue Fenelon, Paris.—The accompanying cut diagrammatically illustrates a reverberatory furnace with three hearths or hearth divisions, burning coal dust. 1, 2 and 3 indicate the hearth divisions, 4 the furnace crown, 5 covers for closing the charging holes, and 6 the space above the hearths in which the flame is formed, and through which the products of combustion pass. 7 indicates a pipe for blowing coal dust into the furnace to form the flame, which dust is fed from a suitable coal dust feeding apparatus 8, the small quantity of air required to blow in the coal dust being supplied by the fan or blower 9 through the pipe 10. The additional air to support combustion is supplied through an opening 11 from a passage 12 which communicates with a regenerator or recuperator 13 arranged beneath the furnace and into which the fan or blower 9 blows air through the pipe 14. 15 is a passage through which the products of combustion are led from the furnace chamber 6 to the regenerator 13. If for example cast iron is to be manufactured from its ores, these ores are charged, with carbon in a suitable form and together with the necessary fluxing agents, into the division 3 of the hearth which is located farthest from the flame, as shown at 16. Under the action of the flame the iron oxide becomes reduced and the molten impure crude iron collects upon the bottom of the hearth, while the slag floats upon the top. The crude iron can then be tapped off out of this division of the hearth and transferred to the next hearth division 2 where a further purification of the



Apparatus for the Manufacture of Iron and Steel.

metal can be made by means of suitable additions under the influence of the higher temperature of the flame. When the cast iron has acquired a suitable compositon it may be removed to be directly used as desired. If on the other hand it is desired to produce steel from ores, the treatment in division 3 of the hearth is carried out as described and in division 2 of the hearth suitable oxidising agents are added to it, such for example, as fresh ore and additional substances for burning away the carbon and for the removal of sulphur and phosphorus. This purifying treatment may either take place in the hearth division 2 entirely or the treatment may be effected in the two hearth divisions 2 and 1, so that the last purifying process is carried out within the sphere of direct influence of the coal dust flame.

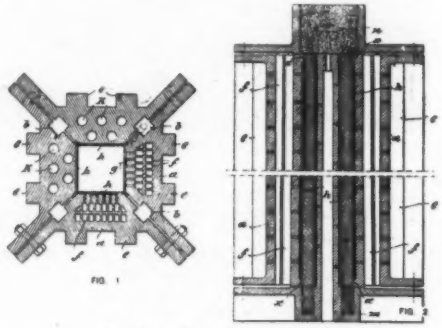
28,982 (1910). *Regenerative Furnaces.* F. Bernhardt, Tempelstrasse, 3, Konigshütte, Upper Silesia, Germany.—Fig. 1 is a longitudinal section, and Fig. 2 a cross section of the furnace; Figs. 3 and 4 are respectively a longitudinal section and a cross section illustrating one form of connection of the gas flue with the furnace. Referring to Fig. 1, the gas flue *a* is connected to the wall *b* of the tilting furnace *c* by means of a joint, which allows of rotation of the furnace, and is easily disconnectable, so that the flue can be removed by a crane. After removal of the flue the entire under wall or face is exposed so that the brick-work of the wall can be easily repaired or renewed. The hot air flue *d* is arranged at the side of the furnace, and joins the distributing channel *e*, from which the air flows vertically or nearly vertically through slot *f*, into the



Regenerative Furnace, by Bernhardt.

furnace c. There may be a plurality of air flues *d* leading to the distributing channel *e*. The upper part *g* of the air flue *d* is hinged at *h*, and a rope *i* attached thereto passes over the roller *k* and has a weight *l* at its lower end, so that the part is balanced and can be conveniently rocked onto a support *m*, as indicated by dotted lines in Fig. 1. When the part *g* has been swung back, as shown, and the flue *a* has been disconnected from the furnace, the flue *a* can be lifted bodily away from the horizontal flue which it joins, the furnace being tilted to remove the channel *e* from the path of the flue *a*. At the junction *n*, between the gas flue *a* and furnace *c*, the connection is so made as to allow of easy rotation when the furnace is tilted, the gas flue remaining in position. A device for this purpose is shown in Figs. 3 and 4.

4,272 (1911). *Moulding Boxes or Flasks for Foundries.* W. Kurze, Wilhelmshütte, Neustadt, on the Rübenberge, near Hannover, Germany.—Fig. 1 is a transverse section of the moulding box; Fig. 2 is a longitudinal section of the same with the core inserted. The box consists of four parts *a*, and its cavity does not precisely correspond to

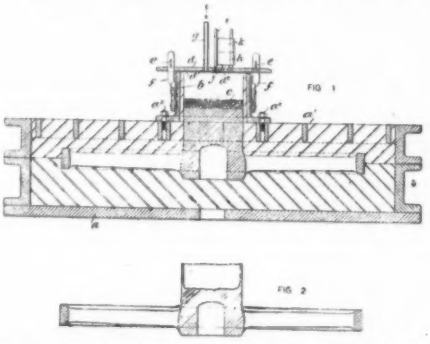


Moulding-box for Foundries.

the casting to be produced, but is slightly larger. Arranged in the interior, by preference at the upper and lower end, are small projecting ledges or ribs *x* (Fig. 2) determining the precise shape of the casting to be produced. Between these ribs an appropriate coating or lining substance *k* is

applied. This lining has a thickness of about 15 to 20 millimetre. The ribs *x* may be movable in the interior of the moulding box, so that by adjusting the ribs vertically to the central axis of the box, the thickness of the lining substance employed between the ribs and consequently the size of the casting to be produced may be varied. Arranged in the individual parts of the box and extending in axial direction, are passages *f* communicating with the atmosphere in order to cool the mould, and adapted to receive and to discharge the gases entering from the lining substance *h* through transverse passages *g*. In place of the passages *f*, cylindrical holes *k* may be provided and connected with the lining. The core used in Fig. 2 is coated in the usual manner with a layer of a lining substance, and is supported and guided in the lower box portion *m* by means of an appropriate projection. The upper box portion *n* is rammed with moulding sand in the usual manner, and provided with casts or intakes. These intake openings may, if desired, be located as shown in Fig. 1 in the crevices or cavities *b*, between the individual parts of the box.

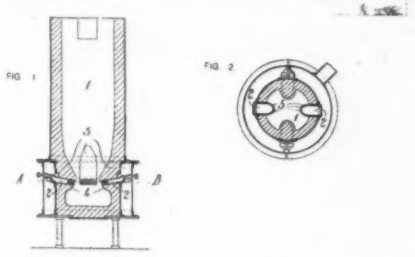
2,772 (1911). *Producing Castings of Steel.* A. C. Rogerson and A. F. Halstead, of Beyer, Peacock & Company, Limited, Gorton, Manchester.—Fig. 1 shows a sectional elevation of an ordinary moulding frame in which a locomotive wheel is being cast, to which the invention has been applied; Fig. 2 shows in section the locomotive wheel just as it has been withdrawn from the flask. The frame *a* is provided with extended mouthpieces *b* secured to the cover a^1, through which the molten metal is poured into the mould, partly filling the extended mouthpiece to form a very short head of metal of sufficient volume to compensate for the amount of shrinkage in the interior of the casting. The surface of the metal is then covered with a layer *c* of charcoal or sand, which serves to delay



Producing Castings of Steel and other Metals.

the process of oxidisation on the surface of the metal and maintain the interior of the metal liquid. An air-tight cover *d* is firmly clamped upon the top of the mouthpiece, such as by means of cottars driven through holes *e* in the projections *f*, which projections are passed through slots in the cover *d*. The cover *d* is made air-tight by means of a copper ring d^1. The cover *d* is provided with a pipe *g*, and after a short duration of time, air under pressure is introduced through the pipe *g* into the mouthpiece *b*, the pressure of which acting upon the short head ensures that the metal is forced to entirely fill the mould, and, as shrinkage takes place, the metal in the small rising head whilst in a fluid state, due to the covering of charcoal, etc., is forced into any cavities caused by such internal shrinkage.

18,414 (1911). *Cupola Furnaces.* P. Anderson, Kyrkogatan 146, Arvika, Sweden.—Figure 1 is a central vertical section of the furnace, and Figure 2 is a horizontal section through the twyers on the line A—B. 1 is the shaft of the furnace and 2 the twyers. These twyers extend into the shaft towards the central axis of the same, and are covered on the upper side by sloping ribs 3 of refractory material, their lower sides being also protected by a similar lining 4. For distributing the air blast, for example, of low pressure, more uniformly in the furnace, the inner ends of the twyers should preferably not be quite open, but covered by a curved wall, which is provided with a plurality of slots or holes 5 arranged in such manner, that the air will enter the furnace in jets spread like a fan, and will issue from the centre as well as from the sides of the twyer without, however, directly striking the adjacent furnace wall. It can easily be seen that by extending the twyers through a certain distance into the furnace shaft



Cupola Furnaces, by Anderson.

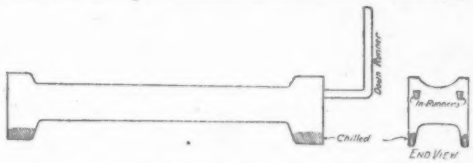
the necessary air for supporting combustion can be supplied to the central portion of the latter. Also by introducing the air in jets in different directions the air is more uniformly distributed and more completely utilised for the combustion. By the introduction of the air closer to the central axis of the furnace and the distribution of the same, the solidification of the slag around the nozzles is also prevented, and finally also the severe wear and burning of the furnace wall which are caused when the air is introduced close to the wall and finds its way along the same.

Queries.

Chilled Parts in Castings.

Will you explain the cause of chilling in the thin section of a casting (a bar-bearer for a mechanical stoker), as shown in the sketch herewith. The bar was cast, as sketched, in green sand, with the chilled section downwards, the mixture being half pig-iron and half our own scrap. Approximate composition of the mixture:—GC., 2.7; CC., 0.66; Si., 1.9; S., 0.07; Mn., 0.8; P., 0.9 per cent.—"G. W. W."

Answer.—An inspection of the chilled portion sent would point to defective moulding as the cause of the trouble. The grey portion of the casting shows a very good, close texture which should be admirable for machining, and the hard portion can only be accounted for by an excess of water in the sand, par-



ticularly at the chilled points. Since this is not a frequent occurrence, it may be presumed that either the sand was not perfectly mixed or—a more likely solution— extra water was introduced in repairing the mould at the points in question. Pouring the metal into an over-damp mould might have resulted in chilling the first metal, and as the method of gating would carry it down the sides of the mould, the chilled metal would be deposited in the recesses. The hot metal on top, however, would neutralise the first chilling effect, except in the extreme end, which would remain in the chilled condition as shown. A little attention to the condition of the sand should remedy the trouble.

Trade Talk.

PERMAN & COMPANY, LIMITED, engineers, etc., have removed to 82-84, Fenchurch Street, E.C.

THE London offices of the Lilleshall Company, Limited, have been removed to Billiter Buildings, Billiter Street, E.C.

THE name of the London General Brass Foundry Company, Limited, has been struck off the register of joint stock companies.

THE CRESCENT FOUNDRY COMPANY, LIMITED, is being wound up voluntarily, with Mr. H. Meredith, of Messrs. Meredith & Company, as liquidator.

THE RŒCHLING EISEN & STALHWERKE, of Volklingen, Germany, have established a branch in New York to handle the business in Röchling electric steel.

THE PEARLITE STEEL COMPANY, LIMITED, of Sheffield, have appointed Messrs. John Burgess & Company, 60, South John Street, Liverpool, as their agents.

AN outbreak of fire occurred on November 20 on the premises of Cocker Brothers, Limited, steel manufacturers, Sheffield, considerable damage being done.

AN outbreak of fire occurred on November 5 at the works of John Brown & Company, Limited, Sheffield. A large quantity of patterns were completely destroyed.

HEAD, WRIGHTSON & COMPANY, LIMITED, of Thornaby-on-Tees, are executing a large order for cast-iron sleepers for the South Indian Railway Company.

IT is announced that the Austrian firm of Messrs. Hofherr and Schrantz have purchased the Austrian factories of Clayton & Shuttleworth, Limited, of Lincoln.

MR. A. MUSKER, of C. and A. Musker (1901), Limited, has established himself in business as a consulting engineer at 1, Northumberland Avenue, London, W.C.

THE shareholders of W. G. Skelton, Corbitt & Company, Limited, have decided to wind up the company voluntarily, Mr. W. H. Smith, of Sheffield, being appointed liquidator.

THE SOUTH DURHAM STEEL AND IRON COMPANY, LIMITED, have acquired three acres of land adjoining their West Hartlepool Works, to provide for the expansion of their business.

MR. JOHN CAWLEY, of 53, Victoria Street, Westminster, London, S.W., has been appointed agent for the Motherwell Wagon and Rolling Stock Company, Limited, of Flemington, Motherwell.

MESSRS. H. P. BERTRAM, J. H. BERTRAM, and L. V. BERTRAM, trading as P. H. Bertram & Sons, brass and iron founders, West Bromwich, are paying a supplemental dividend of 9·32d. in the £.

MESSRS. W. COUP and A. H. PHILLIPS, carrying on business as engineers at 5, Featherstone Buildings, High Holborn, London, under the style of Coup, Phillips & Company, have dissolved partnership.

MESSRS. RICHARDSONS, of Billiter Square Buildings, London, E.C., have just been appointed London representatives of Messrs. Tait & Company, Kobe, Japan, who are opening an engineering department.

ON November 10 an outbreak of fire occurred on the premises of the Farringdon Works and H. Pontifex & Sons, Limited, engineers and brass-founders, Shoe Lane, London, E.C. The damage was considerable.

WM. SUMMERSCALES & SONS, LIMITED, of the Phœnix Foundry and Coney Lane Works, Keighley, have appointed Messrs. White, Wilson & Company, Clive Street, Grangetown, Cardiff, as their West of England agents.

THE partnership hithertofore existing between Messrs. A. M. Russell and J. Lockley, carrying on business as general engineers, at 15, Snow Hill, Wolverhampton, under the style of Russell Brothers & Company, has been dissolved.

MESSRS. J. JACK & W. LOW, carrying on business as engineers, at 291, Cleveland Street, Birkenhead, under the style of Jack & Low, have dissolved partnership. In future the business will be carried on by Mr. J. Jack in his own name.

MESSRS. J. BROOKBANKS & W. BROOKBANKS, carrying on business as vice and anvil manufacturers, at the Queen's Cross Works, Dudley, under the style of Joshua Wilkinson & Sons, have dissolved partnership. Mr. J. Brookbanks will continue the business.

EDGAR ALLEN & COMPANY, LIMITED, Imperial Steel Works, Sheffield, have concluded arrangements with Mr. F. Siemens by which they become sole licensees for Great Britain for the manufacture and supply of the Siemens' patent gas-fired rotary kilns.

THE firm of T. L. Davidson & Company, merchants and engineering agents, 62, Robertson Street, Glasgow, of which Mr. T. L. Davidson and Mr. R. T. Kemp were the sole partners, has been dissolved. The latter will continue the business in his own name, at the same address.

MR. SHERARD COWPER-COLES has now started private laboratories at 1 & 2, Old Pye Street, Westminster, S.W., which are being fitted up especially for electro-chemical and metallurgical work, including electric furnace work for which a 100 h.p. transformer is being installed.

THE International Engineering and Machinery Exhibition, October, 1912, has been recognised by the Board of Trade as an industrial exhibition, under the provisions of the Patents and Designs Act, for the protection of exhibitors showing inventions or designs which have not yet been patented.

A LARGELY-ATTENDED meeting of manufacturers and other productive employers of labour was held on November 21 at the Liverpool Street Hotel, when a federation of London and district industrial employers styled "The London and District Employers' Federation," was formally constituted.

THE directors of Hadfield's Steel Foundry Company, Limited, Sheffield, have resolved to call a meeting of the ordinary shareholders on December 4 to authorise the issue early in the New Year of 100,000 new ordinary shares at par to the ordinary shareholders in the proportion of one new share to every three held.

THE shareholders of the St. Pancras Iron Works Company, Limited, have decided that the company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same. Mr. E. E. Price, of Messrs. Viney, Price & Goodyear, 99, Cheapside, E.C., has been appointed liquidator.

THE TIPTON TUB AND TUBE COMPANY, of Brook Street, Bloomfield, Tipton, Staffs., and 20, Dudley Road Tipton, was recently formed by Messrs. A. Parker, W. Houston, and R. E. Priest. In less than six weeks the company had erected their own works and executed orders, their manufactures including colliery requisites, blast-furnace barrows, engineers' forgings, foundry requisites builders' ironwork, rivetted tubes, etc.

THE CLEVELAND BRIDGE AND ENGINEERING COMPANY, LIMITED, Hurst, Nelson & Company, Limited, the Pearson & Knowles Coal and Iron Company, Limited, and John Spencer & Sons, Limited, have appointed Mr. J. U. R. Grave, of Shanghai, as their representative in China. Mr. Grave formerly represented the Cleveland Bridge and Engineering Company, Limited, as their engineer and manager in China and the Far East.

MR. GEORGE TANGYE, of Heathfield Hall, Birmingham, who, some time ago, purchased the unique collection of Boulton, Watt, and Murdock relics in the Museum of the Soho Foundry, which have been carefully preserved at the Cornwall Works, and have been seen by a large number of visitors from all parts of the world, has now offered them to the Birmingham Corporation. Mr. Tangye's generous offer has been accepted by the Corporation.

THE WITTENER STAHLROHRENWERKE, Witten-on-the-Ruhr, Westphalia, Germany, propose increasing their capital from £175,000 to £275,000 in order to erect a tube plant in England. Half the capital for the new

works will be found by the German company and the remaining half by one of the leading British tube firms, the name of which is not disclosed. It is thought that the new undertaking will be of value to the German firm, enabling them to protect their patents here.

At a meeting of the Engineering Section of the London Chamber of Commerce held on November 4, a resolution was unanimously adopted declaring that the Insurance Bill would make competition at home and abroad with foreign production increasingly difficult or impossible, and that a tax upon employers for the purpose of providing against unemployment, when added to the cost of production, must tend in itself to bring about unemployment. The resolution urged that the unemployment section of the bill should before being passed into law form the subject of a Royal Commission.

The following is a list of new contracts placed by the Government Departments during October, which we extract from the Board of Trade Labour Gazette:—War Office.—Railway rails, etc.: T. Summerson & Sons, Limited, Albert Hill Foundry, Darlington. India Office, Store Department.—Fencing materials: Anderston Foundry Company, Port Clarence, Middlesbrough; W. Bain & Company, Coatbridge. Locomotive spares: R. & W. Hawthorn, Leslie & Company, Limited, Forth Bank Works, Newcastle-on-Tyne. Locomotive tank: Kitson & Company, Limited, Airedale Foundry, Leeds. Pipes, etc., cast-iron: Staveley Coal and Iron Company, Limited, Staveley Ironworks, near Chesterfield; Stanton Iron Works Company, Limited, near Nottingham.

The Highways Committee of the London County Council for some time has had under consideration the question of making more favourable arrangements with regard to the supply of the special trackwork required in connection with the Council's tramways. At present the whole of this special work is obtained from Hadfield's Steel Foundry Company, Limited. As the result of communications with the firm, the latter has offered, if the Council will agree to purchase from it all special work required for a period of five years (a) to give a further discount of 2½ per cent., making 5 per cent. reduction in all, on the prices obtaining before July 1908 and (b) to allow a reduction of 2½ per cent. on the net prices previously agreed to for special work required for renewals.

The London Emery Works Company, of Park, Tottenham, London N., secured the following orders for foundry plant during October:—One portable sand riddling machine, driven by electric motor; one hand ramming turnover moulding machine, complete with pattern-plates for making Dutch stoves and Danish pots, together with a tumbling barrel, and a ball mill for sand and coal-dust grinding (for export to Cuba); one hydraulic flat-table machine, with lifting pin arrangement, for making brass water cocks, etc.; one hand ramming turnover moulding machine for dealing with ring oil bearings, bearing covers, etc.; one hydraulic plant, comprising pump and accumulator and double-acting hydraulic moulding machine, for making light grey iron castings; one hydraulic multiple moulding machine, with pattern-plates, moulding boxes, etc., for making ¾-in. malleable iron elbows (for export to Japan).

Subscriptions have recently been invited at par for 11,000 ordinary £1 shares in the Thames Silica Company, Limited, which has a capital of £30,000 (of which £15,000 is reserved for future issue for further working capital and general purposes of the company). The company has been formed for the purpose (inter alia) of acquiring a plot of freehold land comprising an area of half an acre, or thereabouts, and situate at Chobham, Surrey, on which has been found, says the prospectus, a deposit of practically pure silica, of which 14,000 tons have been actually proved to exist, and should the deposit be found to extend to 24 ft. in depth, as in the adjoining property, it should yield up to 37,000 tons. Under an agreement with Surrey & Company, Limited, the British Griffin Chilled Iron & Steel Company, Limited, agreed to act as sole agents for the sale to foundries of prepared silicious earth from the land in question, and the benefit of this agreement, which is considered an advantageous one, is being transferred to the company.

The London meeting of the Institute of Metals will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W., on Tuesday, January 16, and Wednesday, January 17, 1912. The meeting will commence on Tuesday afternoon, when the president-designate (Professor W. Gowland, F.R.S.) will deliver his inaugural address on the subject of "Copper and its Alloys in early times." The whole of Wednesday, January 17, will, if necessary, be devoted to the reading and discussion of a number of extremely interesting papers, amongst which may be mentioned the following:—"Properties of certain Copper Alloys at high temperature," by G. D. Bengough, M.A.; "Further Experiments on the Inversion at 470 degrees C. in Copper-Zinc Alloys," by Professor H. C. H. Carpenter, M.A., Ph.D.; "The Influence of Oxygen on Copper containing Arsenic or Antimony," by R. H. Greaves; "The Nomenclature of Alloys," by Mr. W. Rosenhain, B.A.; "Poisoned Brass, and its behaviour when heated in vacuo," by Professor T. Turner, M.Sc.; and a paper by Dr. Carl Benedicks, of the University of Stockholm, dealing with some novel experiments on a zinc-antimony alloy. The third annual dinner of the Institute will take place on Tuesday, January 16, at the Criterion Restaurant, Piccadilly Circus, W.

In the Cutlers' Hall, Sheffield, on November 21, a meeting of the manufacturers of the city was held for the purpose of selecting an Advisory Committee in connection with the defence fund, which is being raised for the purpose of preventing the fraudulent use of the name "Sheffield." In answer to the Cutlers' Company's appeal for £15,000, something approaching £11,000 has been raised. Mr. Arthur Balfour, the Master Cutler, who presided, said it was proposed that the Advisory Committee should prosecute in all suitable cases, and take the greatest care to make examples of offenders. The Lord Mayor said the question of the substitution of foreign goods with English marks in the markets of the world was becoming one of immense magnitude, and needed serious tackling. It was agreed that the following be appointed to act as an Advisory Committee to assist the Cutlers' Company in the administration of the defence fun:—(Cutlers Company nominees). The Master Cutler (Messrs. Seebohm & Dieckstahl, Limited), Mr. J. Rossiter Hoyle (Messrs. Thomas Firth & Sons), Mr. T. W. Ward (Messrs. Thos. W. Ward, Limited), Alderman George Senior (Messrs. George Senior & Sons, Limited), Mr. S. J. Robinson (Messrs. W. Jessop & Sons, Limited), Sir Robert Hadfield (Hadfield's Steel Foundry Company, Limited), Colonel A. E. Bingham (Messrs. Walker & Hall, Limited), Alderman H. K. Stephenson (Messrs. Stephenson, Blake & Company), Mr. A. D. Wedgwood (Messrs. Cammell, Laird & Company, Limited), Mr. F. Scott Smith (Messrs. Samuel Fox & Company, Limited, Stocksbridge), and two others to be elected. Proposed by the Lord Mayor, Mr. H. Steel (Messrs. Steel, Peech & Tozer, Limited), Mr. W. Tyzack (Messrs. Needham, Veall & Tyzack, Limited), Mr. P. MacGregor (Messrs. Sanderson, Brothers & Newbould, Limited), Mr. W. F. Beardshaw (Messrs. J. Beardshaw & Son, Limited), Colonel Charles Clifford (Sir W. C. Leng & Company, Limited), Mr. W. Bradbury (Messrs. Thomas Bradbury & Sons, Limited), Mr. W. Crosby (Messrs. E. Allen & Company, Limited), Alderman W. F. Wardley (representing the Table Blade Forgers' and Strikers' Union).

Deaths.

Mr. D. C. Davey, son of the late Mr. C. M. Davey, of Davey, Paxman & Company, Limited, Colchester, died recently.

Mr. A. J. Hughes, of Perrin, Hughes & Company, Limited, brassfounders, Liverpool, died recently, aged 46 years.

Mr. F. Bartle, a partner in Messrs. F. Bartle & Sons, Basset Foundry, Carn Brea, Cornwall, died recently, aged 83 years.

Mr. W. C. Martin, senior partner of the firm of W. C. Martin & Company, engineers, Glasgow, died on October 29.

The death is announced of Mr. J. Shepley, of the Town End Foundry, Limited, Chapel-en-le-Frith, via Stockport, at the age of 73 years.

Mr. A. E. Maxfield, chairman of Sanderson Bros. & Newbould, Limited, crucible steel and edge tool manufacturers, Sheffield, died on November 12, aged 69.

Mr. J. W. Lambert, a departmental manager at the works of Platt Bros. & Company, Limited, Hartford Ironworks, Oldham, died recently, aged 60 years.

The death has occurred suddenly, at Macclesfield, of Mr. Benjamin Harlow, founder of the firm of Benjamin Harlow & Son, engineers and ironfounders, King Edward Street, Macclesfield, Cheshire.

The death occurred, on November 17, at his residence in Terrace Road, Swansea, at the advanced age of 75, of Mr. James Holmes, who for nearly half a century held a managerial position under the firm of Messrs. Vivian & Sons, Swansea.

The death occurred at his residence, Linden, Longhorsley, Northumberland, on November 7, at the age of 82 years, of Mr. L. W. Adamson, who for many years was prominently identified with the commercial life of Tyneside. He was for many years a director, and later chairman of the late firm of John Abbot & Company, engineers, of Gateshead, and he was also a director of Lloyd's British Testing Company, Limited.

The death is announced of Sir Hugh Gilzean Reid, which occurred at his residence, Tenterden Hall, Hendon, Middlesex. Sir Hugh was born at Cruden, Aberdeenshire, in August, 1836, and was therefore seventy-five years of age. Although associated with journalism all his life, and a prominent newspaper owner during the last 50 years, he was also intimately connected with the iron and steel industries, being a director of Richard Hill & Company (1899), Limited, of Middlesbrough, and the Locke Steel Chain Company (1905), Limited, which concern was voluntarily wound up in July, 1910.

New Companies.

Arctic Metals Company, Limited. Capital £2,000 in £1 shares.

Dacre Engineers' Supply, Limited.—Capital £500 in £1 shares.

Crisp Engineering Company, Limited. — Capital £500 in 1s. shares.

Sheffield Climax Steel Company, Limited.—Capital £2,000 in £1 shares.

Job Lee Premier Engineering and Tool Works, Limited.—Capital £6,000 in £1 shares.

Savages, Limited.—Canital £50,000 in £10 shares, to carry on the business of agricultural engineers, etc.

Baltimore Engineering Company, Limited.—Capital £1,000 in £1 shares. Registered office: 19, South John Street, Liverpool.

Weaste Foundry Company, Limited.—Capital £3,000 in £1 shares. Registered office: Tootall Road, Weaste, Lancs.

British Tungsten Metals Syndicate, Limited.—Capital £3,675 in 3,500 ordinary shares of £1 and 3,500 "B" shares of 1s.

Bramco, Limited.—Capital £250 in £1 shares, to carry on the business of engineers, etc. Registered office: 158, Widdrington Road, Coventry.

James R. Kelly & Company, Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers. Registered office: 25, Bridge End, Leeds.

Frederick Pollard & Company, Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers, etc. Registered office: 154, St. Saviour's Road East, Leicester.

Firth, Dunlop & Ranken, Limited:—Capital £10,000 in £1 shares (4,000 preference), to carry on the business of manufacturers of iron, copper, brass, tin and other metals, etc.

Goodfellow & Company, Limited.—Capital £5,000 in £1 shares (2,500 preference), to carry on the business of engineers, etc. Registered office: Mottram Road, Hyde, Cheshire.

Canada Pacific Iron and Steel Syndicate, Limited.—Capital £50,000 in £1 shares, to carry on the business of ironmasters, steel manufacturers, etc. Registered office: Broadway Court, Westminster.

Rankin, Steven & Company, Limited. — Capital £3,000 in £1 shares, to acquire the business of Rankin, Steven & Company, ironfounders, Shettleston. Registered office: 65, West Regent Street, Glasgow.

Speirs, Limited.—Capital £30,000 in 12,000 preference and 18,000 ordinary shares of £1 each, to acquire and carry on the business of Speirs & Company, structural engineers, etc. Registered office: 125, West Regent Street, Glasgow.

Moorwoods, Limited.—Capital £50,000 in £5 shares, to take over the business of manufacturers of armour plate rolls, etc., carried on by Moorwood, Sons & Company, Limited, at Sheffield and elsewhere, together with the leasehold works and undertaking.

A. Dawes & Sons, Limited.—Capital £6,000, to acquire the business now carried on at 131 and 133, London Road, Manchester, under the style of A. Dawes, mill and colliery furnishers, engineers' merchants, etc. Registered office: 133, London Road, Manchester.

Phœnix Metal-Working Company, Limited.—Capital £1,000 in £1 shares, to take over the business of a metal worker, engineer, general iron founder, etc., carried on by C. Crossley, at 12a, Lamport Street, Liverpool, as the Phœnix Metal Working Company.

Mechanical Specialities, Limited.—Capital £500 in £1 shares, to carry on the business of mechanical, electrical and general engineers, etc., and to adopt an agreement with the Jones & Lamson Machine Company, Limited, of 97, Queen Victoria Street, E.C.

Heap & Partners (Canada), Limited.—Capital £5,000 in 300 6 per cent. cumulative preference shares of £10 each and 2,000 ordinary shares of £1 each, to carry on in Canada and elsewhere the business of engineers, manufacturers' agents, engineers' merchants, etc. Registered office: Liver Buildings, Liverpool.

J. Cortin, Limited.—Capital £5,000 in £100 shares, to acquire the businesses of chemical plant manufacturer, engineer, machinist, etc., now carried on by Joseph Titus Corking, at Newcastle-upon-Tyne, under the style of J. J. Corking etc. Registered office: Mushroom Brass Works, St. Lawrence Road, Newcastle-on-Tyne.

Mulholland, Duncan & Company, Limited.—Capital £3,500 in £1 shares, to acquire and take over as a going concern, the business of W. Mulholland and H. Duncan and to carry on the business of engineers and manufacturers and dealers in all kinds of plant and machinery, etc. Registered office: 62, Albert Bridge Road, Belfast.

Scottish Bunsen Smokeless Furnace Company, Limited.—Capital £20,000 in £1 shares, to acquire interests in any patents, etc., in connection with any invention in relation to the combustion, treatment, storage, application, distribution, and use of fuel in furnaces, and to carry on business as ironfounders, etc. Registered office: 103, Bath Street, Glasgow.

Universal System of Machine Moulding and Machinery Company, Limited.—Capital £5,000 in £1 shares, to carry on business as general engineers, etc., and to manufacture and sell under a license, to be obtained from the Societe Anonyme des Etablissements Ph. Bonvillain et E. Ronceray, of Paris, various types of their patent moulding machines and apparatus.

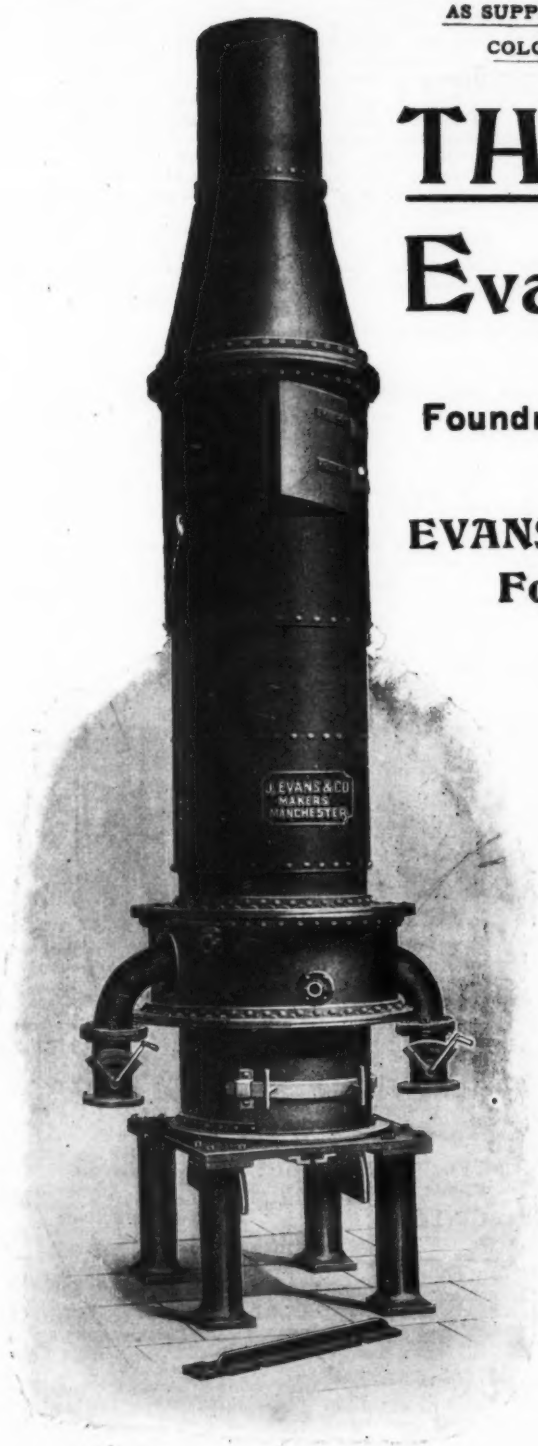
Watford Engineering Works, Limited. — Capital £10,000 in £1 shares, to carry on the business of engineers, founders, dealers in machinery, etc., and to acquire the business carried on by the executors of the late H. J. Rogers, at High Street, Watford, as the Watford Engineering Works, and to adopt an agreement with L. M. Rogers and F. L. Evans. Registered office: Watford Engineering Works, High Street, Watford.

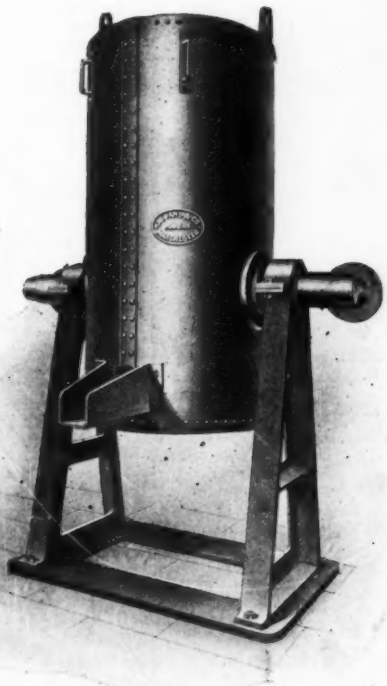
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

Personal.

Mr. Andrew Carnegie has been returned unopposed as Rector of Aberdeen University.

Mr. L. Marshall has been appointed manager to J. Ashton Riley, Limited, Canal Boiler Works, Manchester Road, Huddersfield.

Mr. D. L. Rutherford, engineer-in-chief of the Furness Railway, is the president-elect of the Permanent Way Institution for 1912.

Mr. W. S. Smart, of Birmingham, has been appointed general manager to W. J. Jenkins & Company, Limited, of the Beehive Works, Retford, Notts.

Sir Hugh Bell, Bart., has been re-elected chairman of the Tees Conservancy Commissioners. He has been a member of the Commission for 36 years.

The late Mr. Edwin Foden, founder and a director of Foden's, Limited, left estate of the gross value of £70,217, of which the net personalty has been sworn at £60,436.

The late Mr. J. Birch, of John Birch & Sons, Limited, brass and ironfounders, Walsall, left estate of the gross value of £5,624 12s. 8d., of which the net personalty has been sworn at £4.509 16s. 1d.

The gross value of the estate of the late Mr. J. E. Wilson, a director of John Bagnall & Sons, Limited, chairman of John Brotherton, Limited, and a director of F. W. Cotterill, Limited, is £40,980, with net personalty £37,280.

The late Mr. George Anderson, formerly of George Anderson & Company (1905), Limited, of the Taymouth Engineering Works, Carnoustie, left personal estate of the value of £18,199, in addition to real estate of the estimated value of £30,000.

In accordance with the provisions of the Parliament Act, the Committee of Selection have appointed the Right Hon. C. B. Stuart-Wortley, M.P., as an assessor to assist the Speaker in determining questions as to Money Bills.

Professor Andrew McWilliam, A.R.S.M., M. Met., Professor of Metallurgy in the University of Sheffield, has been appointed by the Government of India to the newly-created post of Metallurgical and Analytical Inspector of Steel in India.

Mr. J. Gilchrist, of Barclay, Curle & Company, Limited, shipbuilders, Glasgow, and Mr. Walter Macfarlane, of Messrs. Walter Macfarlane & Company, ironfounders, Possilpark, Glasgow, have been appointed Deputy-Lieutenants for the City of Glasgow.

Mr. W. J. Coles, late of Messrs. Maxted Knott & Coles, consulting engineers, Hull, has been placed in charge of the cement and crushing machinery department of Edgar Allen & Company, Limited, Sheffield. Mr. Coles' headquarters will be at 52, Queen Victoria Street, E.C.

Legal.

Parliamentary Levies in Scotland.

Judgment was given, on October 21, by Lord Skerrington, in the Edinburgh Court of Sessions, in the action by J. Johnstone, ironmoulder, against the Associated Ironmoulders of Scotland, to have the Court declare that the Association's rule providing for a labour representative in Parliament was *ultra vires*, and should be reduced. In granting a decree of declaration, Lord Skerrington said that the questions raised were the same as those before the House of Lords in the Osborne case. The only defence argued before him was that the legality of the rule and of the consequent levies must be determined by arbitration, but his Lordship found that no bona fide dispute had been disclosed which fell to be so determined. Defendants had stated that they had no intention of disobeying the order of the Court, and his Lordship continued the case as to an injunction to enable them to give a suitable undertaking. Leave was granted to appeal.

A NEW STEEL BARROW

(PATENTED)

"BRABY'S BALANCED BARROW."

The Handiest and Cheapest Barrow in the market. Specially designed for coal, dross, ashes, etc. Its capacity is **25 per cent. greater** than the ordinary style, yet it can be wheeled with **half the labour**, and can be emptied **much more quickly**. It is a **perfectly balanced** barrow, and a full load can be **easily wheeled by a boy.**

NOTE.—This Barrow can be taken right up to mouth of furnace and the ashes drawn into the barrow direct from the furnace.

The "B.B.B."

BRABY for high grade **STEEL**
SHEETS & PLATES up to 15 FEET LONG.
RANGE of GAUGES 8 to 30 W.G.
RANGE of WIDTHS 12 to 60 in.

BRABY for improved wrought **STEEL**
BARROWS, FOGIES, TRUCKS.
GUTTERS, PIPES, &c.

BRABY for Iron and **STEEL**
ROOFS and BUILDINGS.

BRABY for unbreakable **STEEL**
SASHES, CASEMENTS, and
PUTTYLESS ROOFLIGHTS.

BRABY for galvanized corrugated **STEEL**
SHEETS: "EMPRESS" & "SUN" BRANDS

FREDERICK BRABY & Co. Ltd., Eclipse Iron & Galvanising Works & Steel Sheet Rolling Mills, Petershill Road, GLASGOW.

Show Rooms and Aluminium Warehouse, 124, St. Vincent Street, Glasgow.
Rustless Iron, Galvanising and Copper Works, FALKIRK.

Also at London, Deptford, Liverpool, Bristol, Belfast and Dublin. CONTRACTORS to BRITISH and FOREIGN GOVERNMENTS. Teleg.—"Braby, Glasgow."

PURE METALS

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ELDERS FOUNDRY COKE

AS SUPPLIED TO THE
BRITISH
ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	End Nov., 1911.	End Nov., 1910.
Iron—Scotch pig warrants ton	*53/4½	*55/4½
—Middlesbro' warrants ... ton	47/9	49/7
—W.C. M/nos Bessemer ... ton	62 6	66 6
—Stock, Scotch ... ...tons	1,000	1,000
Copper—Chili bars, GMB ton	£59 1 3	£57 11 3
—Stock, Europe and afloat tons	—	86,609
Tin—English ingots ... ton	£201 10 0	£170 5 0
—Straits ... ... ton	£201 10 0	£170 0 0
—Stock, London, Holland, U.S.A., and afloat ...tons	—	18,387
Lead—English pig ... ton	16 2 6	£13 11 3
Spelter—Ord. Silesian ... ton	£26 17 6	£24 0 0
Quicksilver (75lb)... bottle	£8 10 0	£8 0 0
Antimony—Regulus ... ton	£27 10 0 £28 0 0	£28 0 0–£29 0 0

* Settlement price.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	6 15 0
Pipes, 1½ to 2½ in.	4 17 6	to	5 2 6
,, 3 to 4 in.	4 10 0	to	5 0 0
,, 5 to 8 in.	4 7 6	to	4 10 0
,, 10 to 16 in.	4 7 6	to	4 10 0
,, 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 12 6	to	3 15 0
Floor plates (open sand)	2 17 6	to	3 0 0

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows : Heavy wrought (mixed), £2 9s. 0d. ; light wrought, £1 5s. 0d. ; heavy cast, £2 6s. 0d. ; all per ton, f.o.b., London. Copper (clean), £54 10s. 0d. ; brass (clean), £39 10s. 0d. ; lead (usual draft), £14 15s. 0d. ; zinc, £21 5s. 0d. ; all per ton delivered merchant's yard.

"F.T.J." Bookshelf

Pyrometry.

By Chas. R. Darling. London : E. & F. N. Spon, Limited, 57, Haymarket.

The measurement of temperatures is now regarded as an essential in many metallurgical operations, which, until quite recently, relied on the gauge of the operator's eye. The development and perfection of a number of different pyrometers has been largely responsible for this ; for it has been proved that comparatively simple apparatus can be made to give records which are, at least, comparatively accurate for the same class of work. From the works' point of view, the importance of the pyrometer does not lie in its use for ascertaining with scientific accuracy the temperature of a given body, but in its application for recording variations and assisting in the control of operations. With this in mind, the author of this book has made exact measurement of temperature subordinate to the practical utility of the apparatus, and in order to assist in the use of different pyrometers he has outlined clearly the manipulation of each. The fundamental principles of pyrometry are well set forth, however, so that the student of the subject may operate intelligently and not merely by rote. After a discussion on the standards of temperature, the instruments are considered under the six main heads of thermo-electric, resistance, radiation, optical, calorimetric, and fusion pyrometers, under each of which are described those apparatus which have been found to be of practical use. Opinions, of course, differ largely as to the suitability of one or other of the available instruments for a given purpose ; but a study of this book will greatly assist in appreciating what may be done with the different instruments. To those who require to take temperature measurements, too, the book should be instructive regarding the manipulation of the pyrometer.

MR. E. TONKS, who has been connected for forty years with Messrs. Taylor and Farley, Summit Foundry, West Bromwich, has notified his intention of retiring from the general management on the expiration of his agreed term early in the new year. Mr. Charles W. Tonks, his brother, is also retiring from the post of works manager, held for a long period.

MR. W. B. ROMMEL has joined the board of Fraser & Chalmers, Limited.

T. E. MANSERGH.

EVERY DESCRIPTION OF
MOULDERS'
PATENT WOOD, MINERAL and
COAL DUST BLACKINGS
MANUFACTURED.

Wheathill Charcoal Works, SALFORD.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

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Telegrams : "LOWOOD, DEEPCAR."

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

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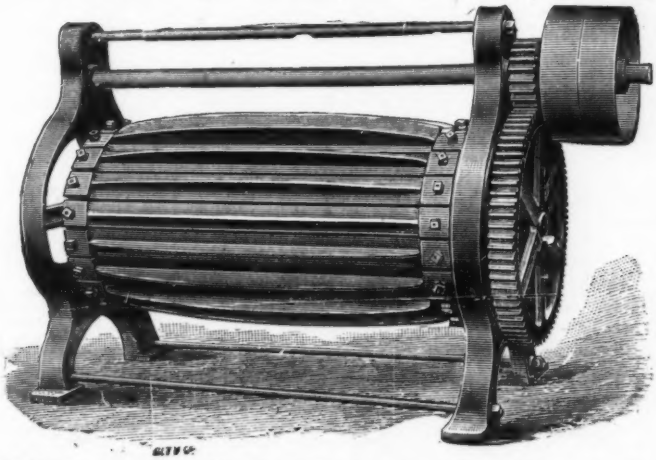
FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



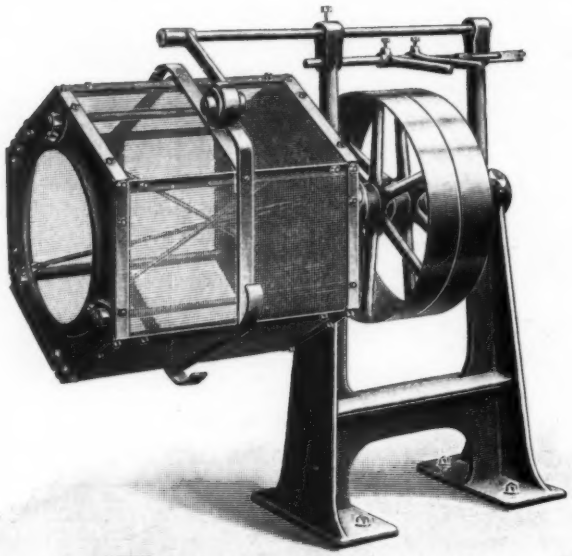
These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without sk ed labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

Rotary Sand Sifter.



How are you sifting your Sand? Are you using the expensive method of hand riddling? If so write for particulars of our Sand Sifters, they save their cost in a few months. The above illustrates the single-ended Rotary Machine, fitted with our special screen knocking arrangement that prevents the sand clogging and doubles the efficiency of the machine. Capacity with ¼ inch mesh, 3 tons per hour. Power required ½ h.p.

Full particulars of other types of Sand Sifters will be posted on application. The largest selection on the market.

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CORE OVENS. SAND BLAST APPARATUS.
ABRASIVE WHEELS. FETTLING MACHINES.

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THE BUYER'S GUIDE

Addresses and further information will be found by reference to the Firm's Advertisement.

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Evans, J. & Co.
London Emery Works Co.
Jackman, J. W., & Co. Ltd.

Air Compressors.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Electrically Driven).
Jackman, J. W., & Co., Ltd.
Marshall & Co. Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Steam).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Belt).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Annealing.
Evans, J. & Co.
Phillips, J. W. & C. J.

Ash Crushing and Washing Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Barrels (Tumbling).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Tilghman's Patent Sand Blast Co., Ltd.

Barrows.
F. Braby & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.

Bellows.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Durrans, Jas., & Sons.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Blacklead.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co.,Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Blowers.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Buffalo Forge Co., Ltd.
Davies, T., & Son.
Dempster, R. & J., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Keith, James, & Blackman, Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Samuelson & Co., Ltd.
Thwaites Bros., Ltd.

Blowers—*cont*
Ward, T. W., Ltd.

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Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Casting Cleaners.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Pneumatic Engineering Appliances Co., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Cement.
Dyson, J. & J.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Lowood, J. Grayson, & Co., Ltd.
Marshall & Co., Horace P.
Metalline Cement Co.
Olsen, Wm.
Plasti-Kion Co.
Silent Machine and Eng. Co.

Chaplets and Studs.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Motherwell, Wm., & Co.
Olsen, Wm.
Wilkinson, T., & Co., Ltd.

Charcoal.
Evans, J., & Co.
Firminger, J. & Co., Ltd.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Mansergh, T. E.
Sykes, James.
Walker, I. & I.

Charging Platforms.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Thwaites Bros., Ltd.

Coal Dust.
Cumming, Wm., & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co
Jackman, J. W., & Co., Ltd.
Mansergh, T. E.
Olsen, Wm.
Sykes, James.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.
Williams, John (Birmingham Sand) Ltd.

Coke (Foundry).
Elders Navigation Collieries.

Coke Breakers.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W., & C. J.

Core Boxes.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.

Core Compounds.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Wilkinson, Thos. & Co.

Core Gums.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd

Core Making Machines.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W. & Co., Ltd.
Jones & Attwood, Ltd.
London Emery Works Co
Marshall, H. P. & Co.
Phillips, J. W. & C. J.

Core Ovens.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hislop, R. & G.
Jackman, J. W. & Co., Ltd.
Jones & Attwood, Ltd.
London Emery Works Co.
Phillips, C. D.
Phillips, J. W. & C. J.
Portway, C. & Son.

Core Ropes.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, T. & Co.

Core Vents.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Cranes.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
Vaughan & Son, Ltd.
Ward, T. W., Ltd.

Crucibles.
Evans, J. & Co.
Hall, Charles, & Co.
Olsen, Wm.

Crucible Furnaces.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Crucible Furnaces (Lift-out)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W. & C. J.

Crucible Furnaces (Tilting)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Crushing Mills.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Cupolas.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T. & Son.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Marshall, H. P. & Co.
Phillips, J. W. & C. J
Thwaites Bros., Ltd.

Cupola Linings.
Evans, J., & Co.
Hall, Charles & Co.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

Emery Grinder
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davis, T., & Son.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.

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London Emery Works Co.

Emery Wheels.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Mitchells Emery Wheel Co.

Facings.
Evans, J. & Co.
Olsen, William

Fans.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Buffalo Forge Co.
Davies, T. & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Jenkins, W. J. & Co., Ltd.
Keith, James, & Blackman, Co., Ltd.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Firebricks.
Durrans, J. & Sons.
Dyson, J. & J.
Evans, J. & Co.
Fyfe & Co., J. R.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
King Bros.
Lowood, J. Grayson, & Co., Ltd.
Pearson, E. J. & J.

Foundry Blacking.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Firminger, J. & Co., Ltd.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Sykes, James.
Olsen, Wm.
Walker, I. & I.
Wilkinson, Thos. & Co., Ltd.
Williams, John (Birmingham Sand) Ltd.

Foundry Brushes.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, C., & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Phillips, J. W. & C. J.

Foundry Ladles.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
McNeil, Chas.
Phillips, J. W. & C. J.
Thwaites Bros Ltd

THE BUYER'S GUIDE.—*Continued.*

Foundry Rattlers or Fettling Drums.
Alldays & Onions
Davies, T., & Son
Durrans, J., & Sons
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co.
London Emery Works Co.
Marshall & Co., Horace
Phillips, J. W. & C. J.

Foundry Sand.
Standard Sand Co., Ltd.
Dyson, J. & J.
Evans, J., & Co.
Gould, George
Jackman, J. W., & Co., Ltd.
Wilkinson & Co., Thos., Ltd.
Williams, J. (Birmingham Sand), Ltd.

Furnaces (Annealing).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hislop, R. & G.
Keith, James, & Blackman, Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Furnaces (Brass).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Furnaces (Melting).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Ground Gannister.
Durrans, J., & Sons.
Dyson, J. & J.
Evans, J., & Co.
Lowood, J. Grayson, & Co.
Walker, I. & I.

Grinding Machines and Tools.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Jones & Attwood, Ltd.
London Emery Works Co.

Hammers (Steam).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Thwaites Bros., Ltd.

Hay Band Spinning Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall &Co., Horace P.

Hoists.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Loam and Sand Mills.
Davies, T., & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Ward, T. W., Ltd.

Melting Furnaces (Oil fired).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Mould Driers.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Moulding Machines.
Adaptable Moulding Machine Co., The
Britannia Foundry Co.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Pickles, James.
Pneumatic Engineering Appliances Co., Ltd.
Samuelson & Co., Ltd.
Stewart, Duncan & Co., Ltd.
Whittaker, Wm., & Sons, Ltd.

Moulding Machines (Hand and Power).
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
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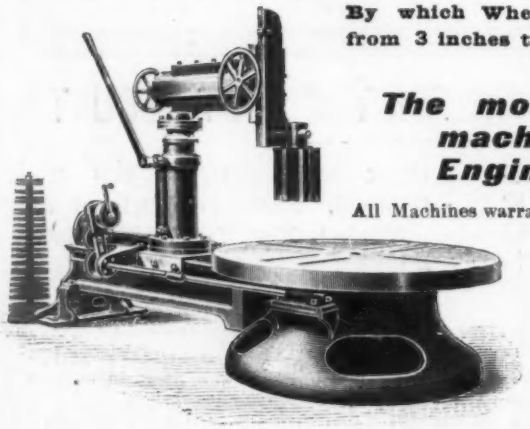

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